Army Science Board
FY2009 Summer Study Follow-On Report

November 2009

PLATFORMS FOR PERSISTENT COMMUNICATIONS, SURVEILLANCE AND RECONNAISSANCE – II

Department of the Army
Assistant Secretary of the Army
(Acquisition, Logistics and Technology)
Washington, D.C. 20310-0103

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16 April 2010

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY FOR ACQUISITION, LOGISTICS AND TECHNOLOGY

SUBJECT: Report of the 2009 Army Science Board Summer Study on Persistent Communications, Surveillance and Reconnaissance-II

I am pleased to forward the final report of the Army Science Board (ASB) Study on Persistent Communications, Surveillance and Reconnaissance-II. The report offers recommendations to the Army on enhancing and optimizing the mix and capabilities of communications, surveillance and reconnaissance mission payloads and platforms.

The Terms of Reference signed by the Assistant Secretary of the Army for Acquisition, Logistics and Technology in 2008 tasked the ASB to analyze the complexities of providing communications, surveillance and reconnaissance (CSR) for a broad range of support missions. Improvements in these areas will enhance the capabilities and security of all Army ground forces. Support for continuous high bandwidth communications on the move and providing timely high quality surveillance and reconnaissance information are prerequisites for the netcentric operations envisioned for the future Army. Particularly relevant to effective future CSR are the capabilities and benefits of high altitude airships and aerostats which offer the potential for extraordinary endurance, low operational cost and modest support requirements in both equipment and manpower.

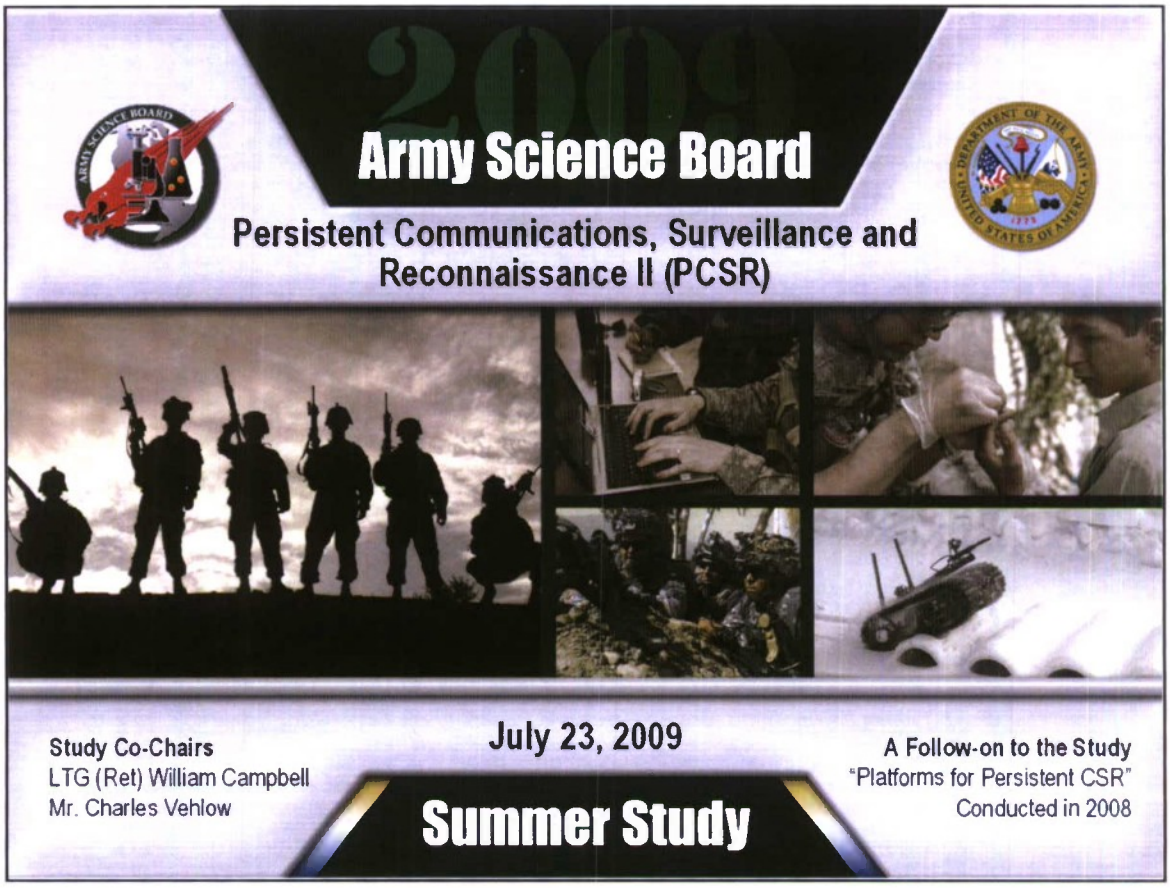
The report includes discussion of a flexible analytical model that was essential in arriving at the findings and recommendations of the study and can be used to compare the relative values of different combinations of aerial platforms and associated payloads to accomplish specified CSR missions.

I endorse the study's findings and recommendations and encourage you to forward this report to the Secretary of the Army.

Frank H. Akers, Jr.
Chair, Army Science Board

CONTENTS

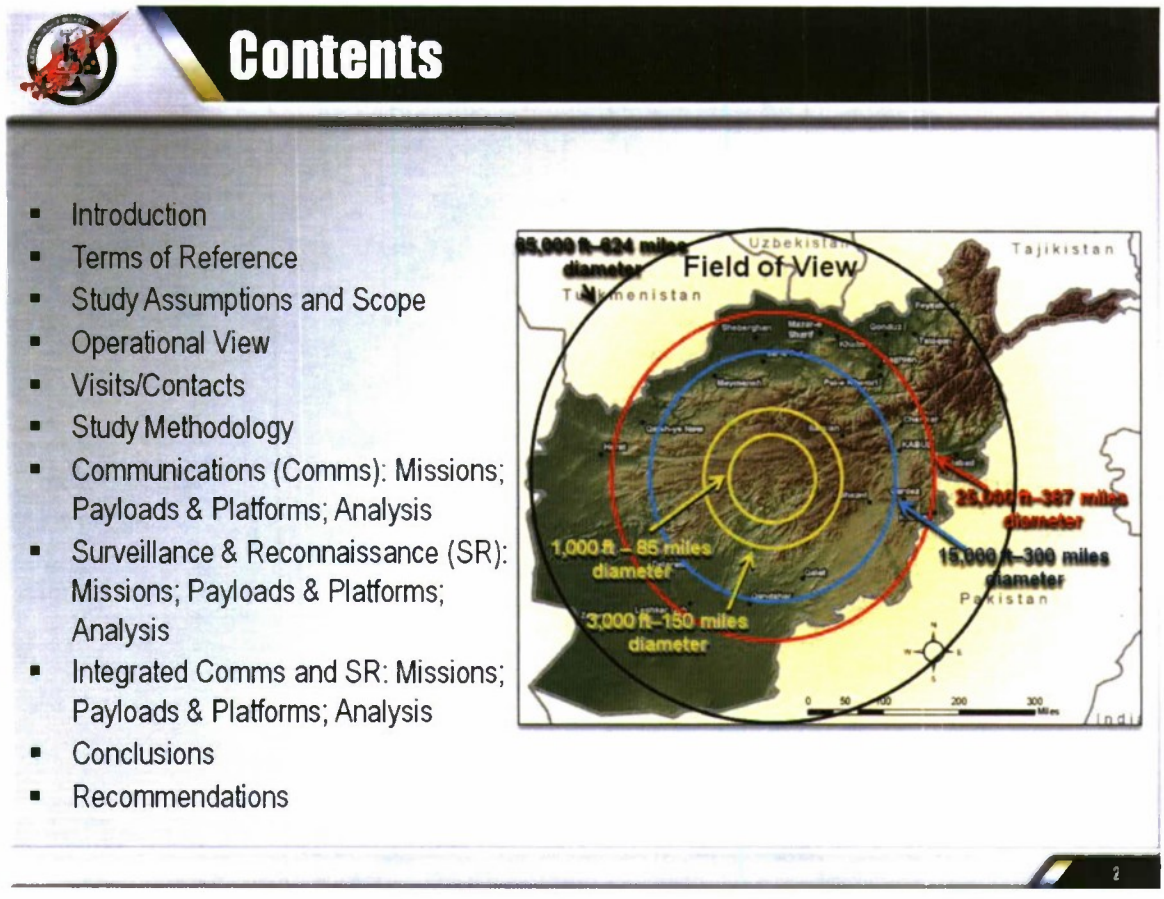
FINAL BRIEFING OF THE
2009 ARMY SCIENCE BOARD
ON
PERSISTENT COMMUNICATIONS, SURVEILLANCE AND RECONNAISSANCE
PHASE II



This report provides an assessment of multiple aerial platform and payload combinations that could be employed to conduct persistent communications, surveillance, and reconnaissance (PCSR) missions in current conflict scenarios.

It summarizes the results of a two phase Army Science Board Summer Study. Phase I of the study, conducted in 2008, evaluated 12 classes of unmanned aerial platforms. Phase II of the study, conducted in 2009, identified payloads for potential deployment on those platforms and evaluated 36 payload/platform options for PCSR. Conclusions and recommendation are included in this report for the Army's consideration.

The sponsor for this study was the Commander of the U.S. Army Space and Missile Defense Command/Army Forces Strategic Command (SMDC/ARSTRAT), LTG Kevin Campbell. The Principal Deputy Assistant Secretary of the Army (Acquisition, Logistics and Technology) (ASA(ALT)), Mr. Dean G. Popps, tasked the ASB to perform the PCSR study with a focus on the needs of the brigade combat team (BCT) and below.



The presentation follows the agenda shown on this chart..

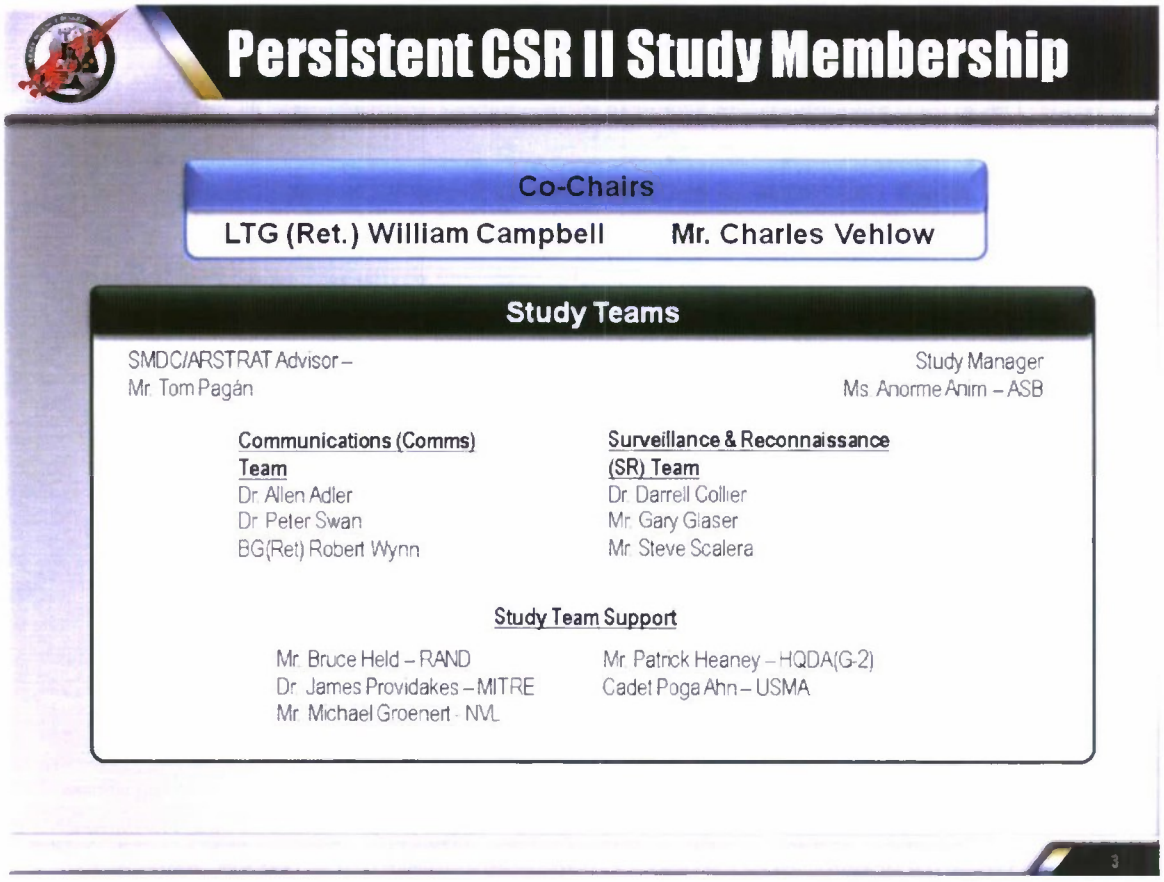
To provide context, the briefing begins with a summary of the Terms of Reference, our assumptions and scope of the study, an operational view of the PCSR architectural framework in graphic form, and identification of the organizations that provided expertise and input to the study.

Next is a summary of our methodology for data collection and comparative value analysis using a model based on the Analytic Hierarchy Process (AHP).

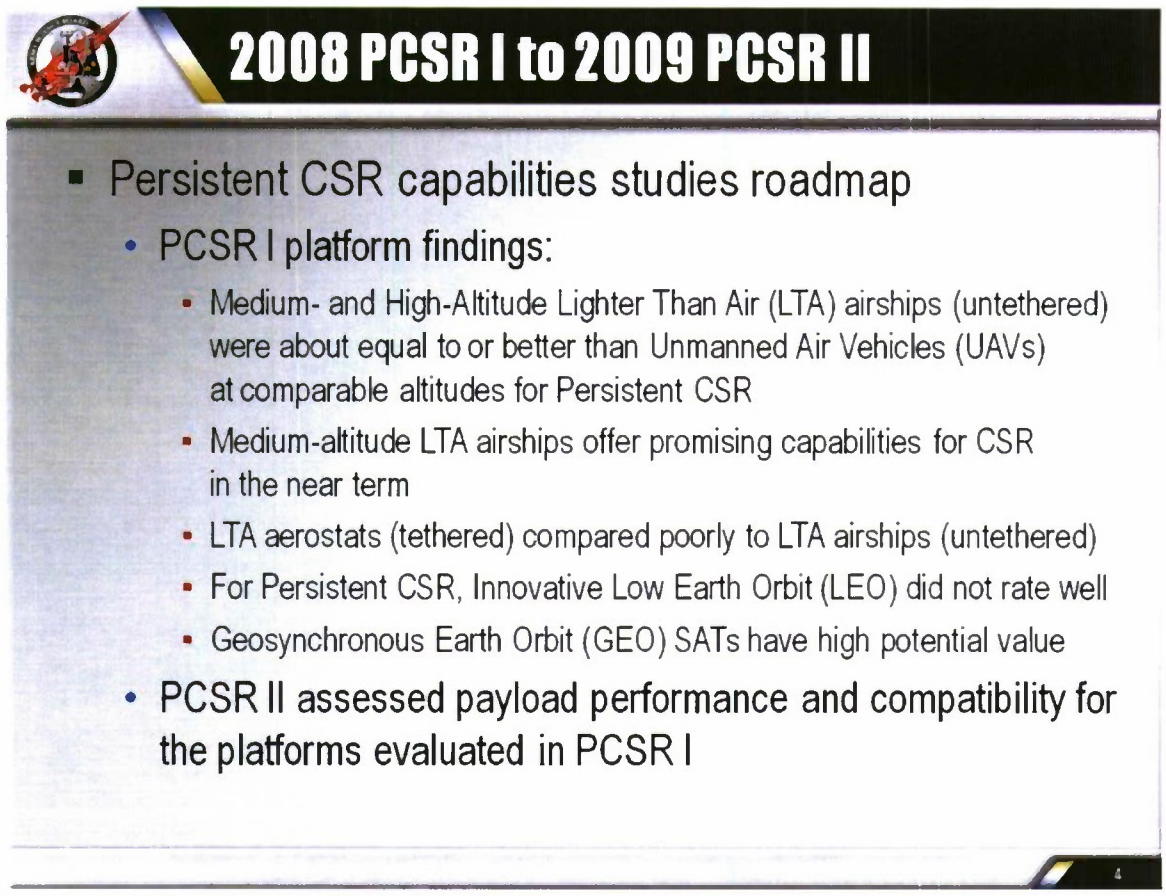
That sets the stage for presentations showing comparative values of 17 payload/platform options for conducting *communications* missions; 13 payload/platform options for conducting *surveillance and reconnaissance* missions; and 6 payload/platforms options for conducting *integrated communications and surveillance and reconnaissance* missions simultaneously from the same platform.

The final portion of the briefing provides our conclusions and recommendations.

The figure on the right of the slide shows coverage areas from platforms operating at altitudes extending from 1,000 to 65,000 feet. It is superimposed over Afghanistan. Although satellites are not shown on the chart, an analysis of satellites for communications missions are included. Satellites used for surveillance and reconnaissance missions were not within the scope of this study. Note that the actual coverage that can be achieved within the concentric circles will be affected multiple factors like terrain, weather, and payload characteristics, which are included in our analysis.



The composition and structure of the Army Science Board panel that conducted the study are shown here. Although its membership is relatively small, the panel includes a diverse set of professionals with military, business, and academic credentials as well as expertise in the disciplines of engineering, science, communications and sensor/radar systems, and military operations. Detailed backgrounds of panel members can be found in the Army Science Board Biographical Sketch Book.



This slide presents a roadmap from the Phase I study completed in 2008 to the Phase II study completed in 2009. Last year the panel assessed platforms; this year the panel assessed platform and payload combinations.

Last year's study showed that medium- and high-altitude airships have very high value and compare well to unmanned aerial vehicles (UAVs) at the same altitudes. Moreover, medium lighter-than-air (LTA) platforms offer promising capabilities in the near term. The 2008 study also found that LTA aerostats that are tethered compared poorly to untethered LTA platforms because of mobility issues. Note, however, the tethered variant would be preferred in certain situations (like base camp security missions). Geosynchronous Earth orbit (GEO) satellites were found to have high potential value, while low Earth orbit (LEO) satellites (for example, "operationally responsive space" satellites) had low value due to time-on-station issues.

The following summarizes the 2008 PCSR I study and its findings and recommendations.

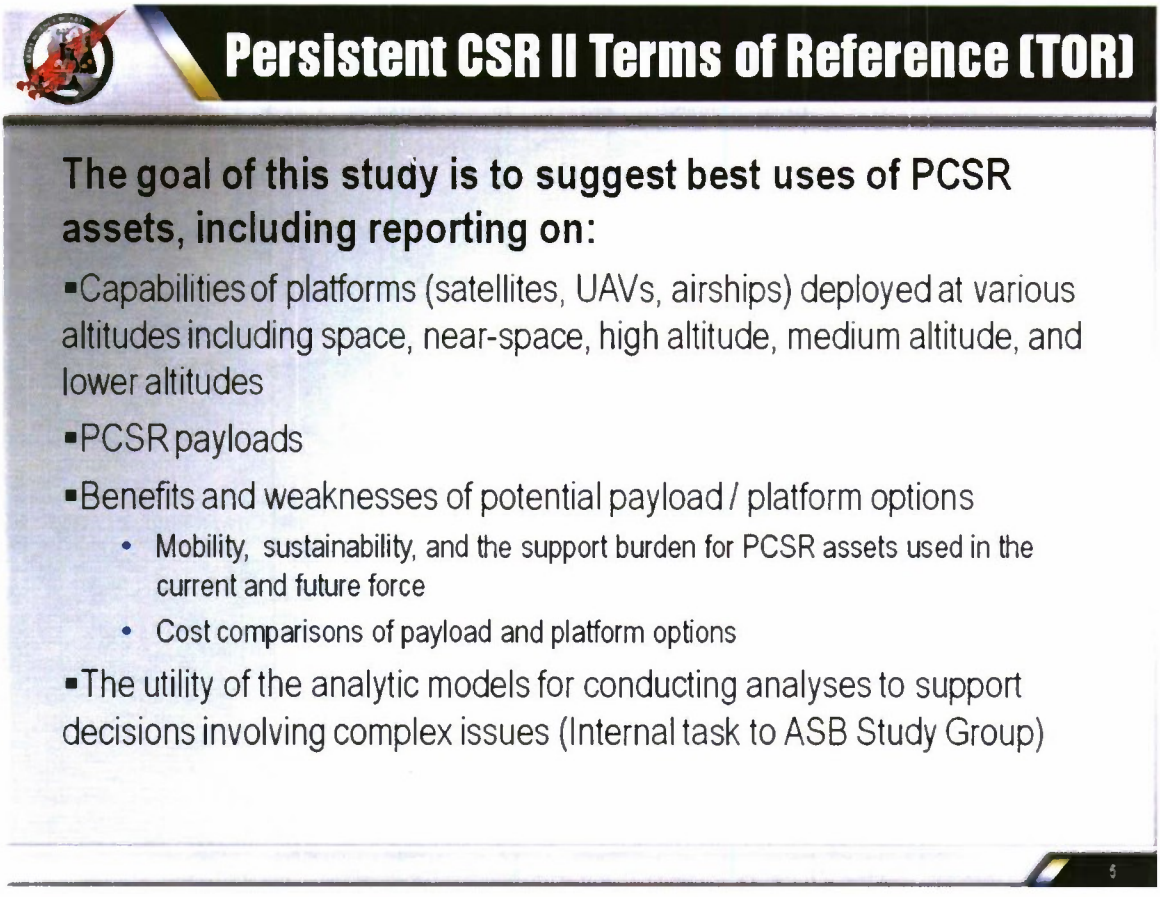
Studies of military operations indicate a need for improvements in persistent communications, reconnaissance, and surveillance (PCSR).

The Army Science Board (ASB) investigated capabilities of platforms deployed in space, near space, and lower altitudes and assessed tradeoffs among benefits, weaknesses, costs, and logistics burdens associated with platform types. The study used a model to assess platform types versus relevant characteristics. Key findings include: persistence is not well defined; coverage gaps exist; communications relay capabilities are inadequate; use of commercial space platforms for communications relay is very costly; large aircraft

(e.g., KC–135) could be utilized for communications relay; proponency for CSR platforms is distributed and many solutions are ad hoc; no integrated mission analysis of alternatives (AoA) was found; satellites are not sufficiently responsive to lower echelon commanders; unmanned platforms are increasingly effective and accepted; and LTA platforms have great potential.

Major recommendations include: assign proponency for LTA to the Aviation Center; retain proponency for high-altitude LTA platforms at the Space and Missile Defense Command (SMDC); accelerate medium-altitude LTA (untethered) prototypes for joint CSR experiments; invest to mature high-altitude LTA airship CSR platforms; form an LTA integrated product team (IPT) of technologists, material developers, and combat developers; and conduct an integrated AoA for CSR platforms mixes.

The study sponsor requested that the team continue its assessment of PCSR by evaluating combinations of platforms and associated communications, surveillance, and reconnaissance payloads and identifying those configurations that would best satisfy PCSR missions.



The goal of the study as defined in the Terms of Reference (TOR) (Appendix A) was to suggest best uses of PCSR assets to include reporting on (1) platforms (including space- and near-space-based capabilities; high- and medium-altitude long endurance UAVs and airships; and lower altitude UAVs); and (2) payloads that could be deployed on those platforms.

The TOR also asked for an assessment of benefits and weaknesses of payload/platform options to include such criteria as mobility, sustainability, support burden, and costs. This type of assessment clearly requires a model tailored to facilitate comparative analysis with the flexibility to vary the weights of the criteria in order to gain insight into the relative values of the options under varying conditions and priorities.

As a consequence, the panel chose to use the same type of Analytic Hierarchy Process (AHP) model that was employed in the Phase I study. This approach was considered to be appropriate because it supports decisions that involve both tangible and intangible features that need to be measured and traded off to determine how well the options meet the objectives of the decisionmaker.

Beyond the immediate goal of suggesting best uses of PCSR assets, the panel was also asked to provide its views on the utility of analytical models of this nature for conducting analyses in support of decisions involving complex issues.

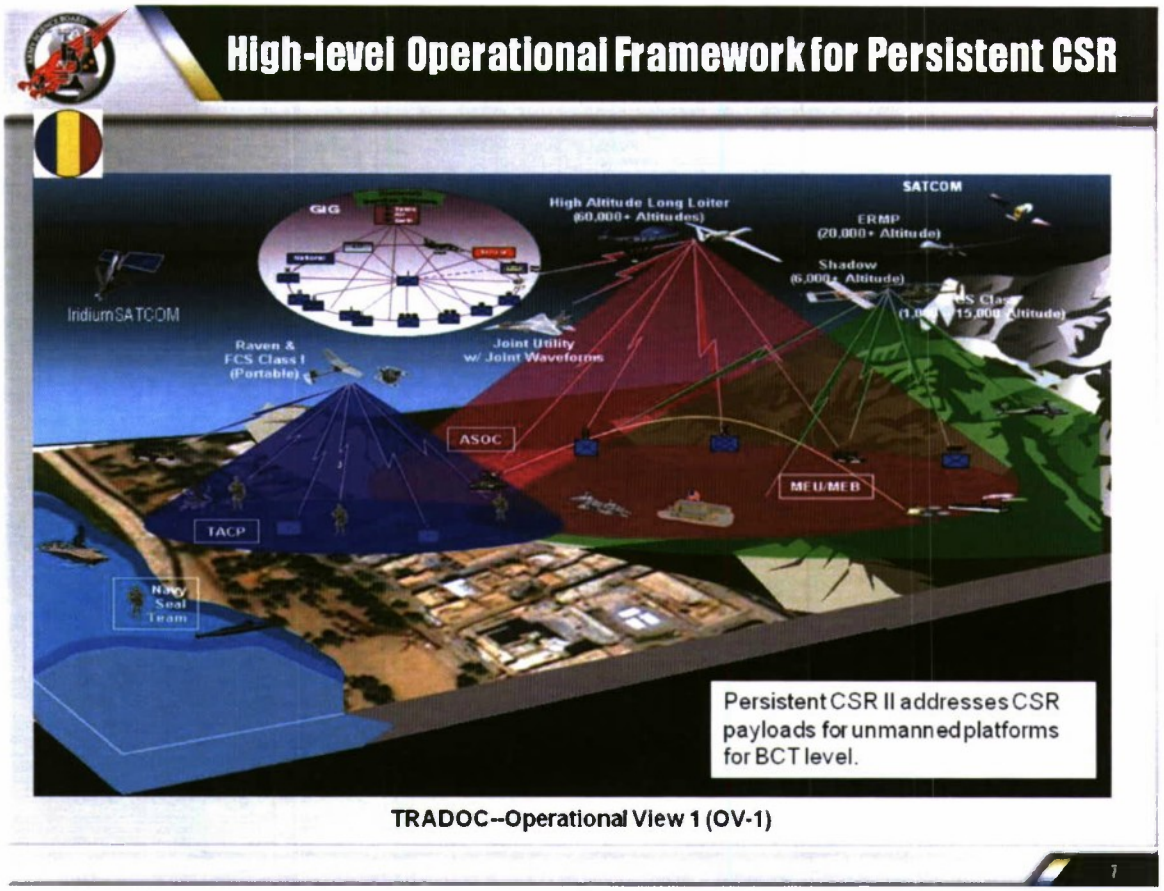
Study Assumptions and Scope

- Assume Afghanistan and Iraq
- Assume existing / planned sensors and comms devices
  - Focus on unmanned air/space platforms
  - Do not consider ground-based systems
- Focus on Brigade Combat Team (BCT) and below
- SR in theater is near-real time and sensor data links are integral to the system
- Intelligence dissemination and fusion were not considered; evaluated sensors only
- Analysis of Comms and SR will be done independently and then merged
- Focus on 3–5-year timeframe

The study was bounded by the key assumptions shown on the facing slide. The mission was constrained to the current conflict and enemies; CSR payloads were limited to those that currently exist or are planned for acquisition and deployment within the 3- to 5-year timeframe; and the focus was on unmanned aerial platforms and space platforms. Ground-based systems were not addressed. The study focused on the needs of the brigade combat team (BCT) and lower echelons with service to the disadvantaged user being a matter of key importance.

For surveillance and reconnaissance, we assumed that collection would be accomplished in the theater of operations and that sensor data links would be integral to all collection platforms to enable near-real-time support to end users. The intelligence function was not addressed per guidance from the sponsor. Satellite platforms were not included in the surveillance and reconnaissance options that we assessed due to security classification constraints. However, satellites were included in the analysis of communications options.

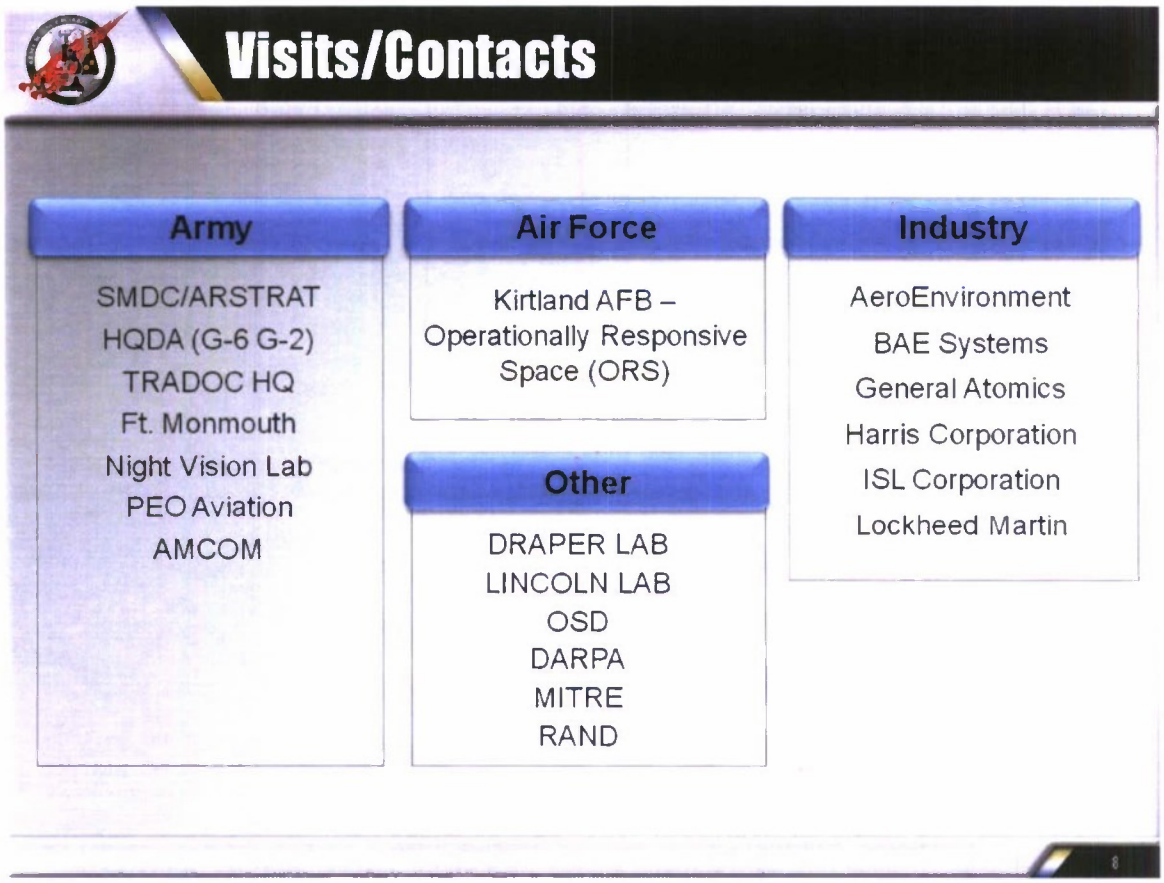
To reduce complexity of the analysis and to ensure that mission-related insights were not lost through aggregation, the analysis was conducted by separate subpanels, one focused on communications and the other on surveillance and reconnaissance. After the analysis was completed by each subpanel, the full panel came together and conducted an assessment of options to execute integrated PCSR operations concurrently on the same platform.



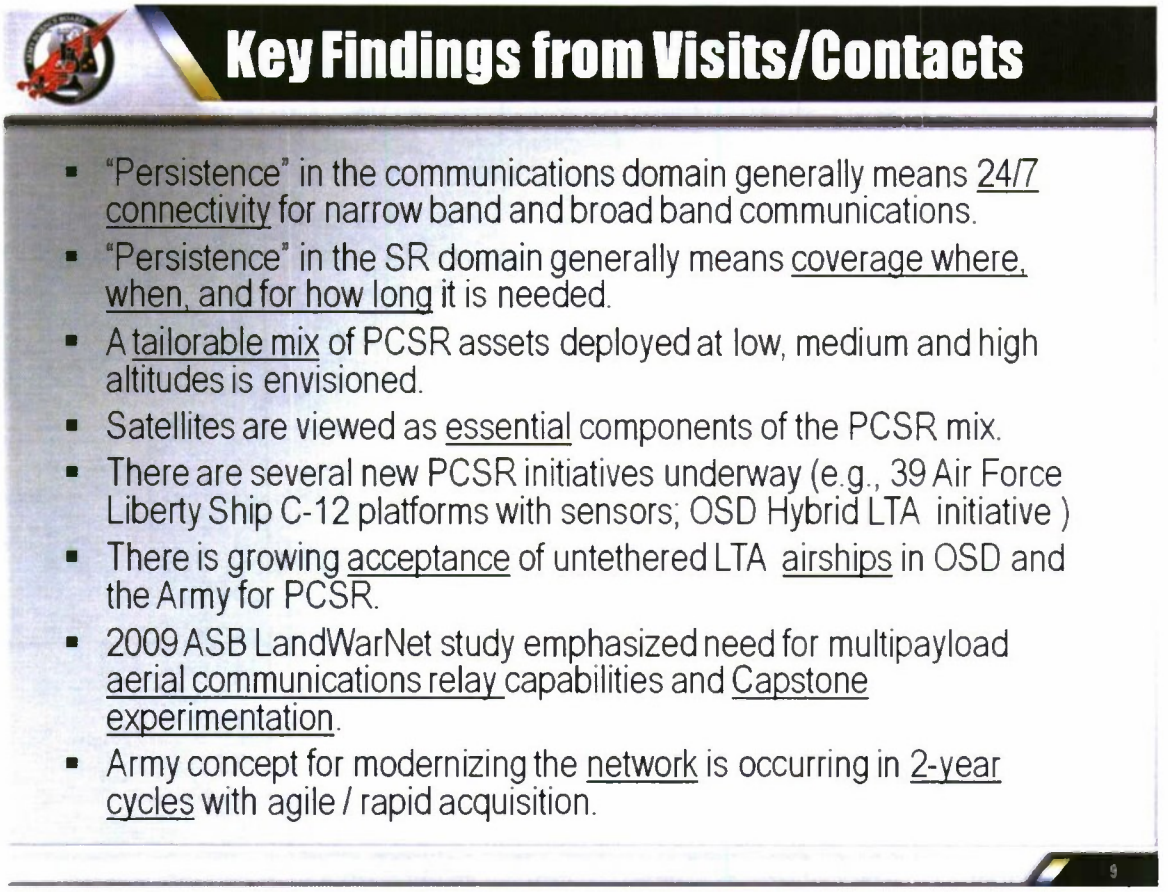
The above slide provides a frame of reference for the study by showing aerial and space-based PCSR assets that could provide support to a BCT. It shows nodes and platforms in the global information grid (GiG) system of systems at multiple layers from mud to space that are anticipated in the 2013 timeframe.

The graphic shows the interactions between the architecture and its environment, and among systems in the architecture. It provides a quick, high-level description of the architecture, its coverage, and its connectivity.

This operational view served as the starting point for identifying opportunities to enhance, thicken, and modify the network to improve its capacity to deliver support to commanders at all levels "...what they need, when they need it, for as long as they need it." It also allowed us to evaluate other assets (e.g., tethered aerostats) in the context of the overarching framework.



The panel met with representatives of multiple organizations to gain insights on technology, material development efforts, combat development activities, and warfighters' needs based on recent combat experience in irregular warfare environments. This included reviews of the documentation collected in PCSR I study and other relevant documents provided by federally funded research and development centers, defense industrial firms, Office of the Secretary of Defense (OSD) elements, and Air Force and Army organizations shown on this slide. (Annex C provides greater detail on our visits and contacts.)



Key findings from our interactions with experts are shown on this slide. They are key because they had a significant impact on the construction of our analytical model and execution of the analytical process.

Persistence has varying definitions. For communications, it means providing connectivity 24/7/365 in both wideband and narrowband domains; for surveillance and reconnaissance missions, however, it generally means providing commanders coverage where they need it, when they need it, and for the duration they require it.

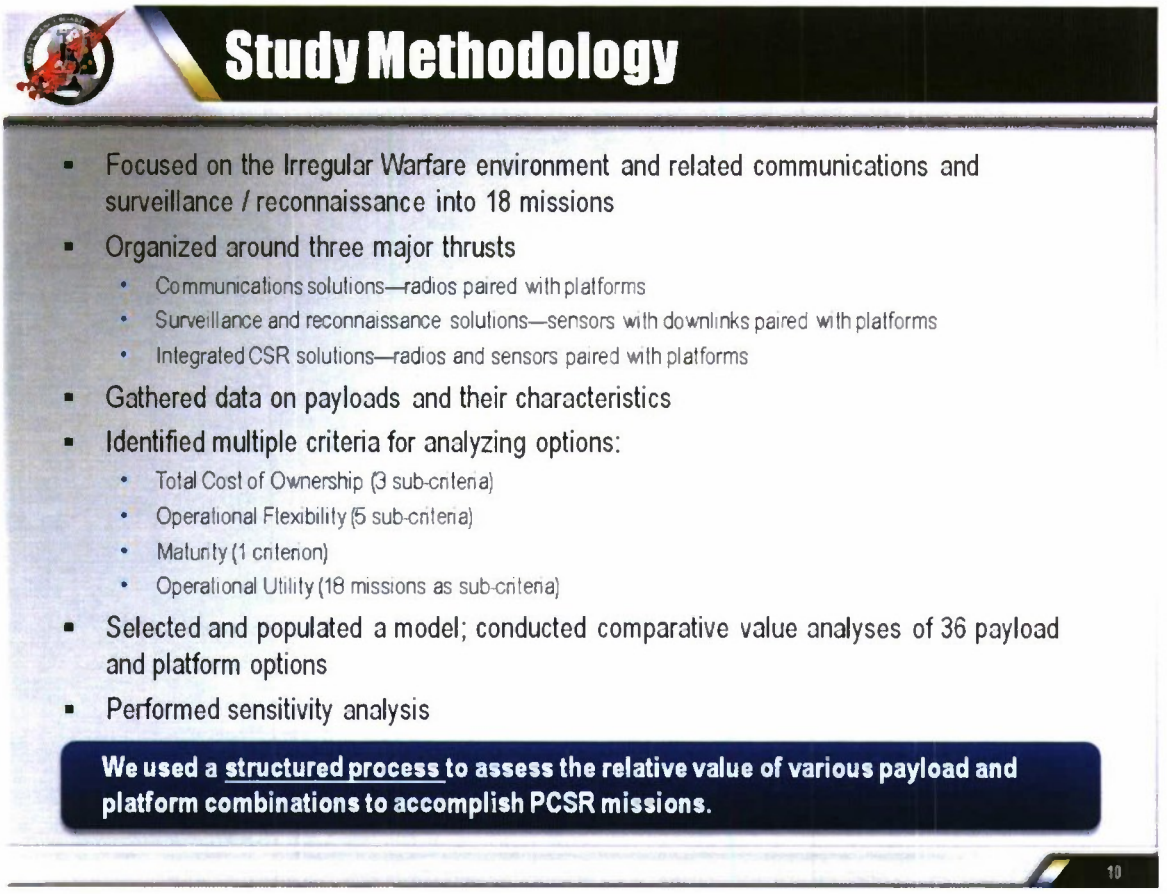
There is no single silver bullet. Consequently a tailorable mix of PCSR assets deployed at low, medium, and high altitudes is envisioned. Satellites are widely deployed and are viewed as essential components of the PCSR mix.

In addition to the variety of aerial and space PCSR capabilities deployed today, there are several new initiatives underway. Some are programs of record (PORs), while others are initiatives responding to urgent operational needs stated by combatant commanders or outgrowths of high-level studies. Among the latter category are two that warrant special mention: (1) the Air Force initiative to acquire 39 Liberty Ship (C–12) platforms equipped with sensor packages, and (2) a hybrid LTA initiative sponsored by the Under Secretary of Defense for Intelligence (USD(I)) that has been delegated to the Army for execution.

There is growing recognition of the potential value of untethered LTA airships and acceptance of this option for operational experimentation and deployment. The 2008 Phase I PCSR report was used by OSD in a recent Deep Dive study. The USD(I) and

Army G–2 were personally briefed on the Phase I study and asked to be briefed on the results of the Phase II study.

Multiple findings by the PCSR II study and the ASB LandWarNet 2009 study converge. Both see the need for multi-payload packages, aerial communications relay capabilities, and capstone experimentation. Both also see the need for agility in the acquisition process to accommodate the Army's emerging concept to modernize the network incrementally in 2-year cycles in lieu of the traditional DoD 5000 process that is designed to deliver complete solutions via an elongated acquisition process



The study panel's overarching methodology was to use meetings, visits, and document research to collect an updated baseline of information; employ the baseline as a point of reference when developing an analytical model; and apply the model to assess options, draw conclusions, and make recommendations. As indicated in the blue banner on the slide, we employed a structured process to evaluate the potential means (i.e., payload and platform combinations) to accomplish a well-defined suite of communications and surveillance and reconnaissance missions.

We began by decomposing the generic communications and surveillance and reconnaissance missions into 18 more detailed sub-missions. Next we organized our study activities into three discrete thrusts:

- Radios were paired with platforms as potential means to accomplish communications missions.

- Sensors were paired with platforms as potential means to accomplish surveillance and reconnaissance missions.

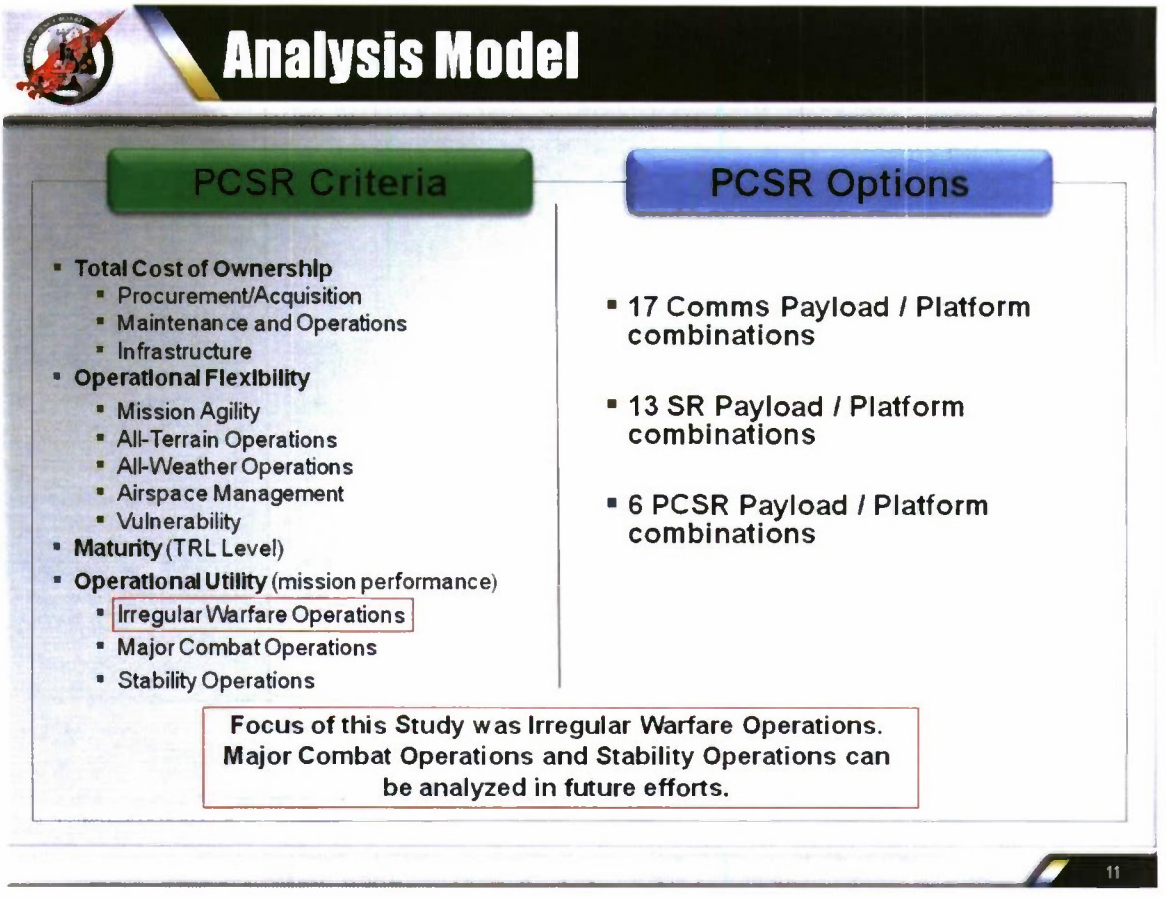
- Integrated sensor/radio combinations were paired with platforms as potential means to accomplish composite communications and surveillance and reconnaissance missions.

After determining the feasibility of the potential payload/platform combinations based on known size, weight, and power (SWAP) characteristics, we selected 17 potential communications solutions, 13 potential surveillance and reconnaissance solutions, and 6 poten-

tial integrated communications and surveillance and reconnaissance solutions for evaluation.

Next, we identified criteria to be used in the evaluation process. The top-level criteria were total cost of ownership, operational flexibility, maturity, and operational utility (i.e., mission effectiveness).

Finally, we exercised a tailored AHP model to conduct a comparative analysis of 36 payload/platform options versus the criteria that included the 18 sub-missions previously discussed. We ran multiple iterations of the model, varying the weights of the criteria to show how the relative values of the options changed as decision criteria were modified.



This slide shows the top-level evaluation criteria with their subcriteria that were used in evaluating the 36 PCSR options summarized on the right half of the slide. All major criteria were equally weighted for base case analysis (i.e., 25 percent each). All subcriteria were equally weighted as components of their parent category. During sensitivity analysis, the weights were varied according to diverse assumptions about the decisionmakers' preferences.

Total cost of ownership had three equally weighted subcomponents (procurement/acquisition costs; maintenance and operations costs; and infrastructure costs).

Operational flexibility had five equally weighted subcomponents (mission agility; all-terrain operations; all-weather operations; airspace management; and vulnerability).

Maturity had one subcomponent (technology readiness level).

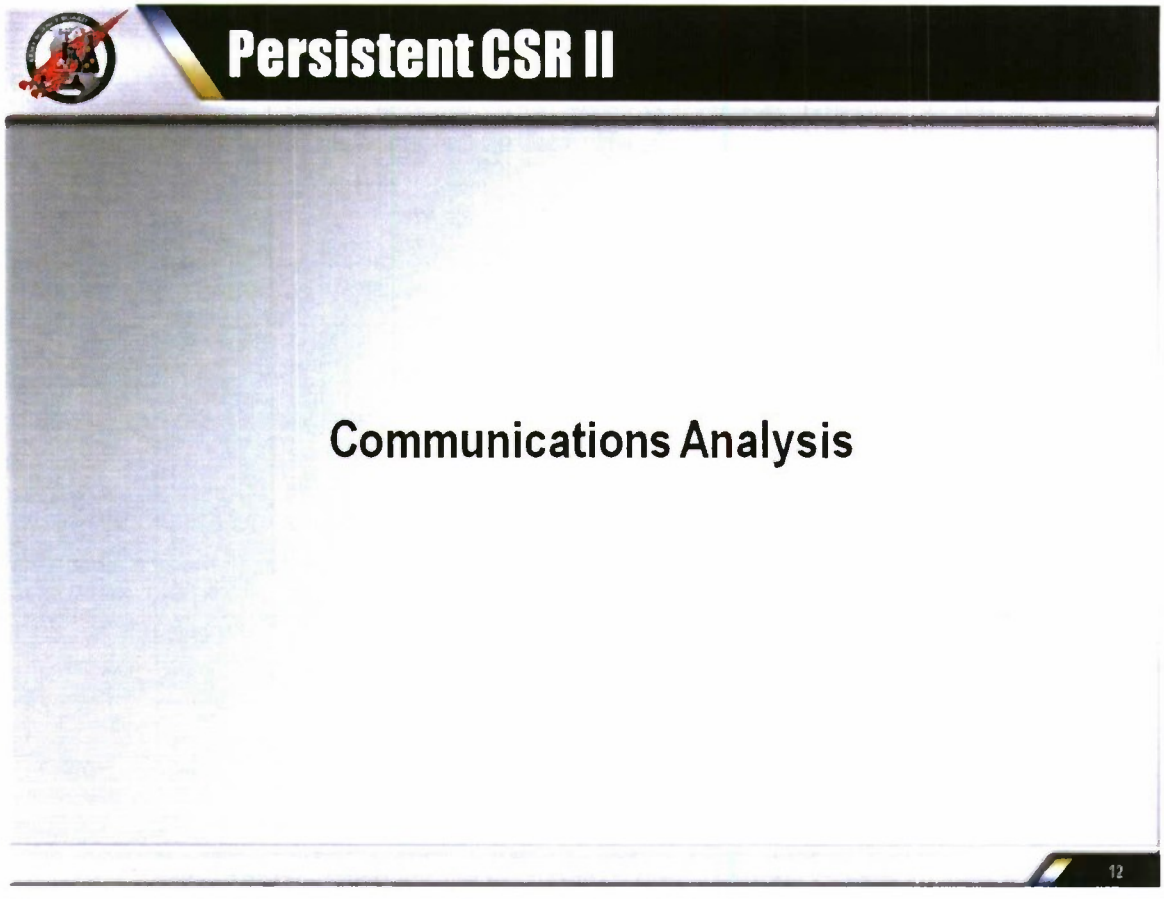
Operational utility consisted of submissions identified for three broad categories of operations with each submission having equal weight within their category. For purposes of this study, we structured the analysis specifically on irregular warfare operations, which had 18 sub-missions assigned across the communications and surveillance and reconnaissance domains. Those sub-missions are evaluated on succeeding slides.

Note: We did not attempt to evaluate the areas of major combat operations or stability operations because the focus of this study was directed to be on current conflicts. Inclusion of all three types of operations in our evaluation would have distorted the results of an analysis that was essentially focused on current operations in Afghanistan. Nonethe-

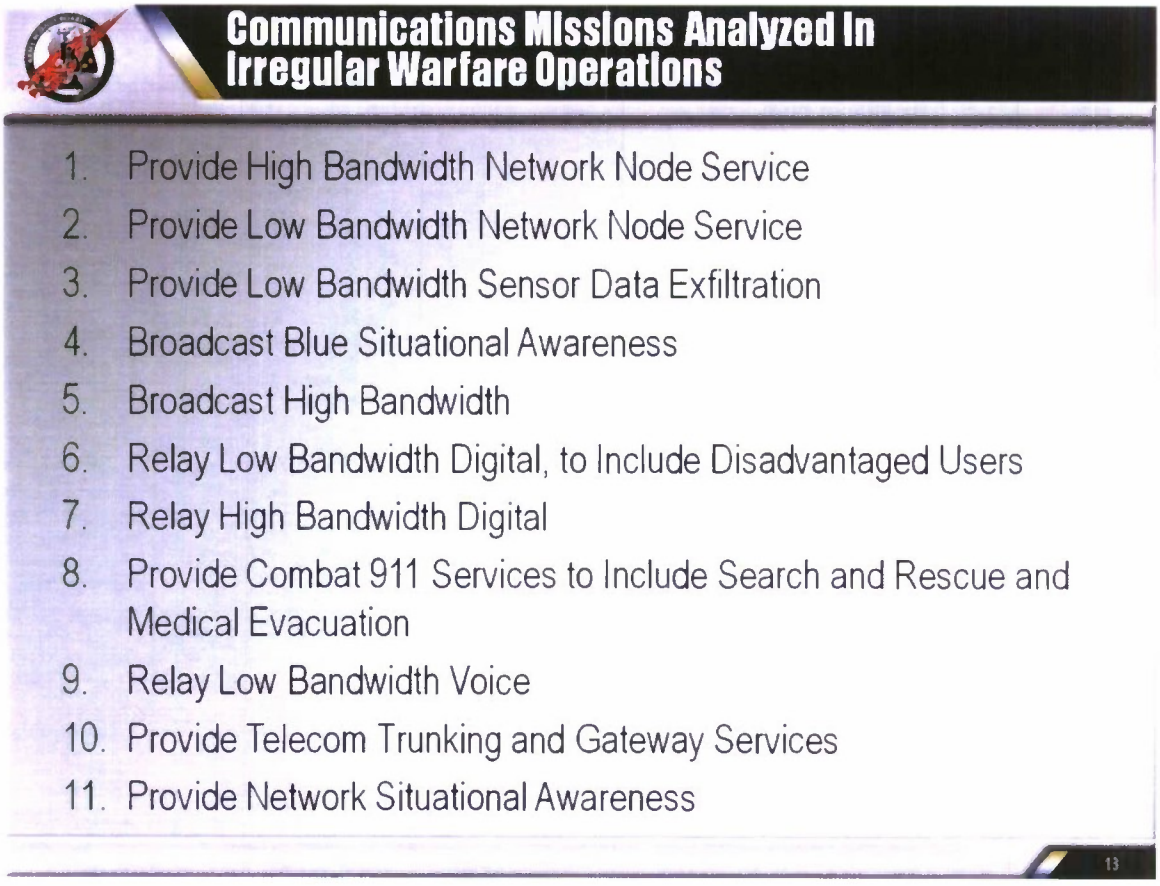
less, the model ean be used in the future to evaluate these additional operational domains either individually or eolleetively.

We ehose the AHP model beeause it is a proven struetured teehnique that is useful in eomplex deeisionmaking, partieularly where there is a laek of eomprehensive quantified empirieal data. It helps deeisionmakers understand the problem and seleet solutions that satisfy the deeision eriteria they ehoose. The model ineorporates psyehology and mathematies in a manner that supports quantifying the elements of the problem (using quantitative data when available and expert judgment when it is not), assoeiating the eriteria with objeetives, and evaluating options using pair-wise judgments about the relative value (e.g., "twiee as good") of eaeh solution versus eaeh of the others for eaeh evaluation eriterion and the missions.

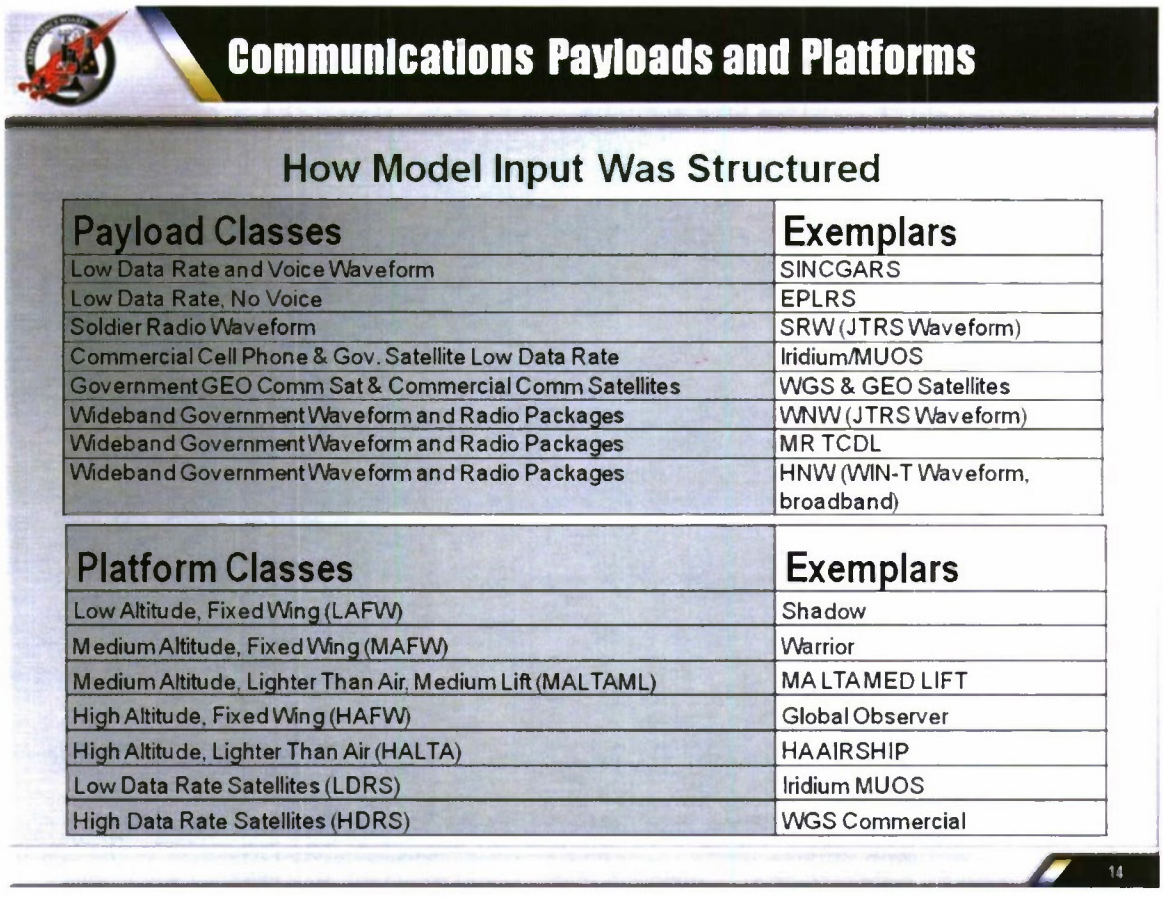
The "hierarchy" element of the proeess involves deeomposing the problem into a hierarehy of subeomponents as we did with the missions and eriteria that are diseussed in more detail in sueeeeding slides. We eompared elements of the solution to one another in a pair-wise manner based largely on expert judgments made by the panel and entered the relative evaluations (on a seale of plus 9 through minus 9) into the model. The model eonverted these evaluations into values that were proeessed and eompared over the eomplete set of potential solutions being considered, and histograms were generated to show the relative values of the potential solutions both numerieally and graphieally.



The next set of slides shows the elements of analysis for communications missions and the comparative evaluation of the options.



This slide shows how we decomposed the communications mission in irregular warfare operations into 11 subcomponents. The missions include high-bandwidth and low-bandwidth voice, data, and video media. Specialty missions like Blue Force Tracking, Combat 911 (Sheriff's Net), and connectivity to disadvantaged users were included. Collectively, these missions provide a comprehensive suite of capabilities at the granularity required for a rigorous analysis of options.



This slide identifies the classes of payloads and platforms used to form payload/platform options for analysis as potential "means" to accomplish the full suite of missions identified on the previous slide. Exemplars including legacy, in-development, and commercial options are shown for each class of payload and platform. Note that two variations of airships are included. In addition, both low- and high-data-rate satellites are included with a commercial and military version of each (i.e., an option with Iridium, UHF Tactical Satellite (TACSAT), and Mobile User Objective System (MUOS) for low-bandwidth communications; and an option with Wideband Global Satellite (WGS) and commercial satellite communications (SATCOM) for high-bandwidth communications). Communications payload exemplars in brief:

- SINCGARS: The Single Channel Ground and Airborne Radio System is a widely deployed narrowband tactical radio providing voice and data communications.

- EPLRS: The Enhanced Position Location Reporting System is a legacy tactical radio system providing narrowband data transmission capabilities on the battlefield. It is the backbone of the Tactical Internet deployed by the Army.

- SRW: Soldier Radio Waveform is a transformational capability being delivered by the Joint Tactical Radio System (JTRS) program to provide secure networked communications for dismounted warfighters on the battlefield.

- Iridium/MUOS: Iridium is a commercial satellite constellation that can provide secure voice and data support to military users with special narrowband satellite phones; MUOS is the next-generation UHF narrowband military satellite.

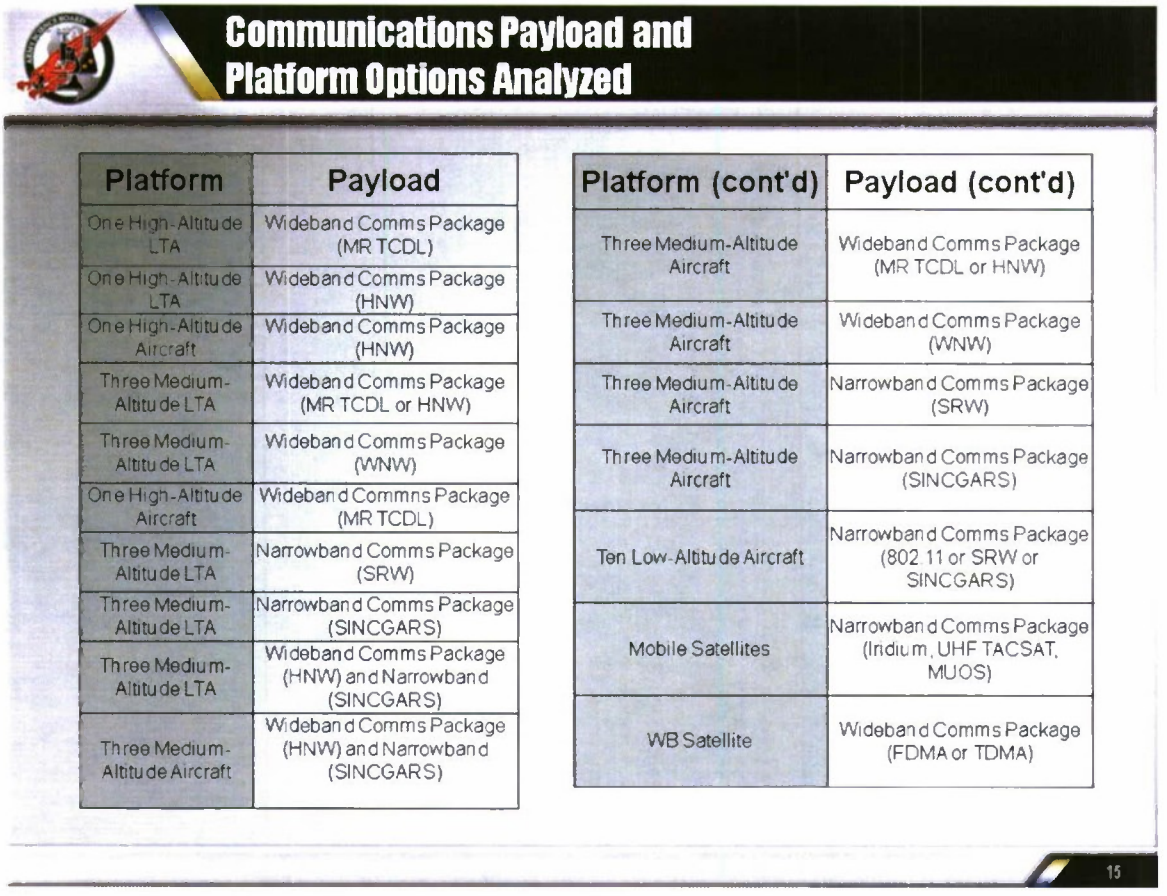
- WGS and GEO Satellites: WGS, previously named Wideband Gap-Filler Satellite, is a military system providing broadband eommunieations support; GEO refers to eommereial geosynehronous satellites providing broadband eapabilities.

- WNW: Wideband Networking Waveform is a broadband transformational capability being delivered by the JTRS program to provide seeure networked eommunieations for mounted warfighters on the battlefield.

- MR TCDL: Multirole Taetieal Command Data Link is a secure data link used to send secure data and streaming video links from airborne platforms to ground stations.

- HNW: Highband Networking Waveform is a broadband transformational eapability being delivered by the Warfighter Information Network (WIN–T) program to provide seeure battlefield eonneetivity and reachback.

- Communieations platform exemplars include low-, medium-, and high-altitude platforms and satellites. The UAVs and airships are further charaeterized in the backup slides.

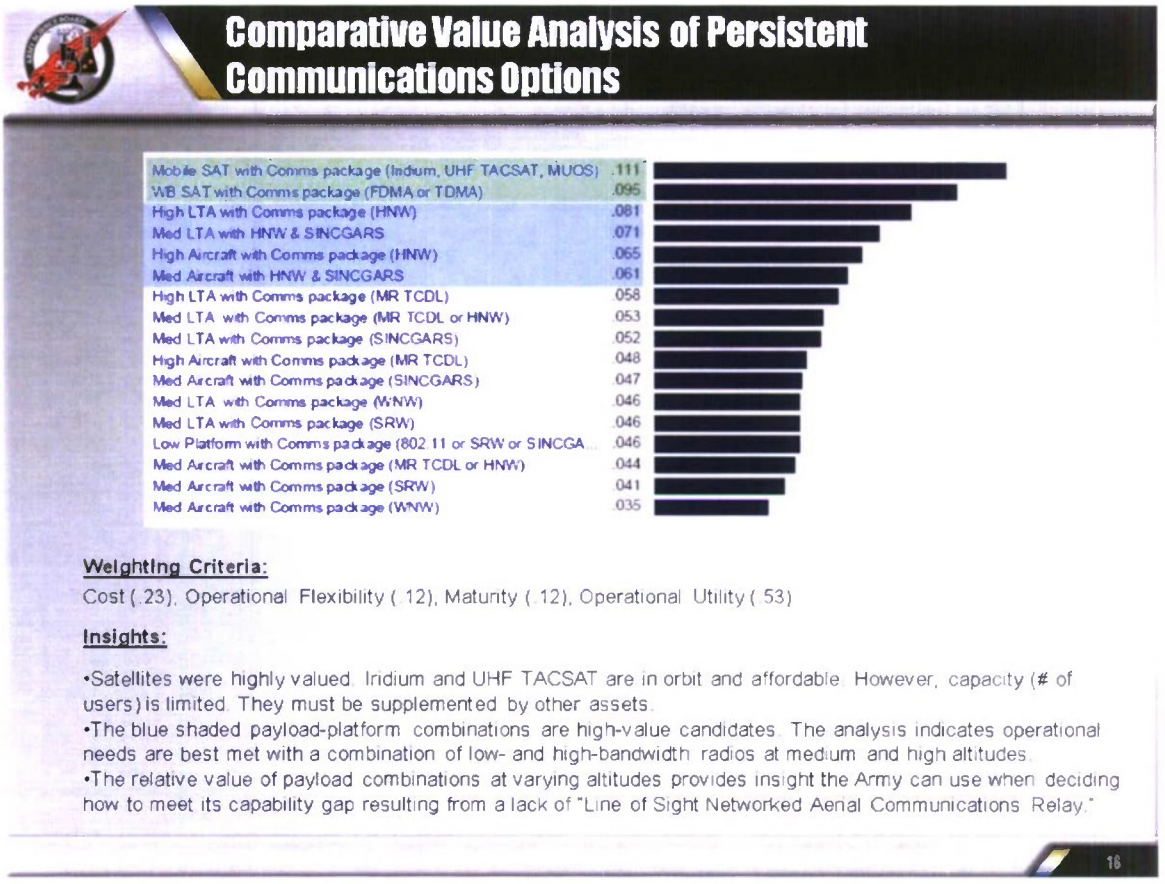


This slide shows the 17 payload/platform combinations chosen for analysis. Most of these are single-payload options, but some options include combinations of wideband and narrowband payloads on platforms that have the SWAP capacity to accommodate multiple payloads.

To ensure that we were making realistic comparisons of options for "persistent" communications, we used the following quantities of platform/payload combinations to provide for 24/7 coverage:

- Low-altitude aircraft: 10
- Medium-altitude UAVs and aerostats: 3
- Satellites and high-altitude UAVs and aerostats: 1

Central to the value analysis of each option is the pair-wise comparison of the relative merit of each option to each other option for each criterion as described in the preceding discussion of the AHP model.



This slide shows the results of *one* representative run of the model.

The Weighting Criteria in the middle of the page is the "derived base case" used for comparison in this report. It heavily weights operational utility at about half; with cost about half as important as operational utility; and with operational flexibility and maturity each about one-fourth as important as operational utility.

The upper left portion of the slide shows the 17 options arrayed by relative value. The numbers to the immediate right of the options are the values computed by the AHP model. The numbers add to 1.000, with a high of 0.111 for a constellation of Iridium, UHF TACSAT, and MUOS narrowband satellites and a low of 0.035 for an option of three medium-altitude aircraft (Warrior).

The upper right of the slide shows the values relative values in histogram form.

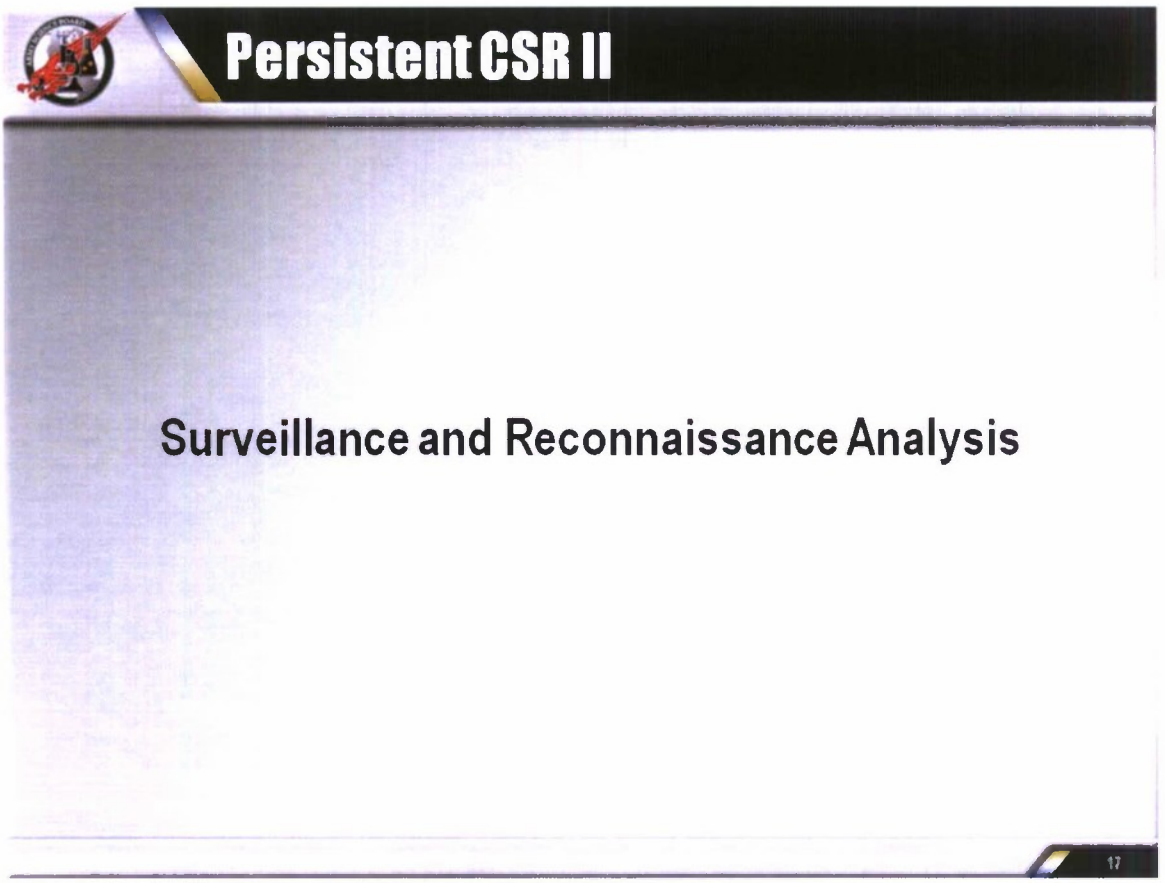
Looking at the results of the run, we can see that, as expected, there is no silver bullet than meets all of the missions. Rather, a combination of payload/platform options will be necessary to meet the full suite of missions effectively.

The green highlighted options at the top of the chart (narrowband and wideband SATCOM) indicate that satellites have very high value. However, the number of users they can support is not sufficient, so they will have to be supplemented by other assets.

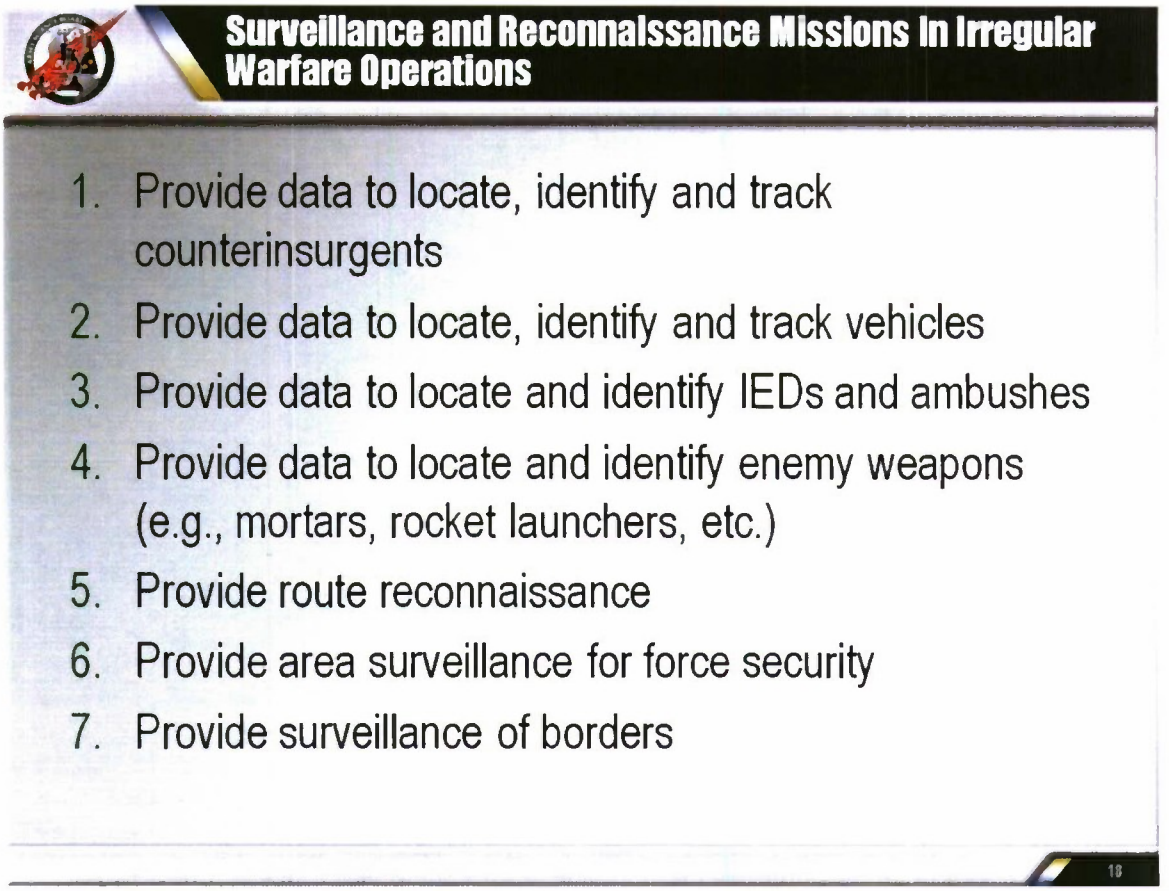
The blue highlighted options near the top of the chart are high-value candidates that in combination can provide narrowband and broadband capabilities.

The relative value of the payload combinations deployed at varying altitudes provides insight that the Army can use in considering options to meet its acknowledged capability gap resulting from a lack of "Line-of-Sight Networked Aerial Communications Relay."

Although the values computed for some options are relatively low when considering their capacity to meet all 11 communications sub-missions, these options may be the best solutions for individual sub-missions.



The next set of slides shows the elements of analysis for surveillance and reconnaissance missions and the comparative evaluation of the options.



This slide shows how we decomposed the surveillance and reconnaissance mission in irregular warfare operations into seven subcomponents. The missions include tracking, locating, and identifying people, vehicles, and weapons as well as route reconnaissance, force security, and border surveillance. Collectively, these missions provide a comprehensive suite of capabilities at the granularity required for rigorous analysis of options.

SR Payloads and Platforms Considered

Payload Classes	Exemplars
Full Motion Video; EO/IR	POP300
Full Motion Video; Image Intensification; EO/IR	MTS-B
Flash	Flash (overwatch MWIR
Hyperspectral Imagery	Aurora+
SIGINT	TSP
RADAR/Ground Moving Target Indicator – Vehicle	Lynx
RADAR/Ground Moving Target Indicator – Dismount	ARTEMIS
RADAR/Ground Moving Target Indicator – Dismount	VADER
Wide Area; Optics; Ground Moving Target Indicator – Dismount	AWAPSS+
Wide Area; Optics; Ground Moving Target Indicator - Dismount	ARGUS+

Platform Classes	Exemplars
Low-Altitude Fixed Wing (LAFW)	Shadow
Medium-Altitude, Fixed Wing (MAFW)	Warrior
Medium-Altitude, Rotary Wing (MARW)	Firescout
Medium-Altitude, Lighter Than Air, Medium Lift (MALTAML)	MA MED LIFT
Medium-Altitude, Lighter Than Air, Heavy Lift (MALTAHL)	MA HEAVY LIFT
High-Altitude Fixed Wing (HAFW)	Global Observer
High-Altitude Lighter Than Air (HALTA)	HA AIRSHIP

Note: SR platforms also included Common Data Link (CDL) and/or Tactical Common Data Link (TCDL) for real-time surveillance

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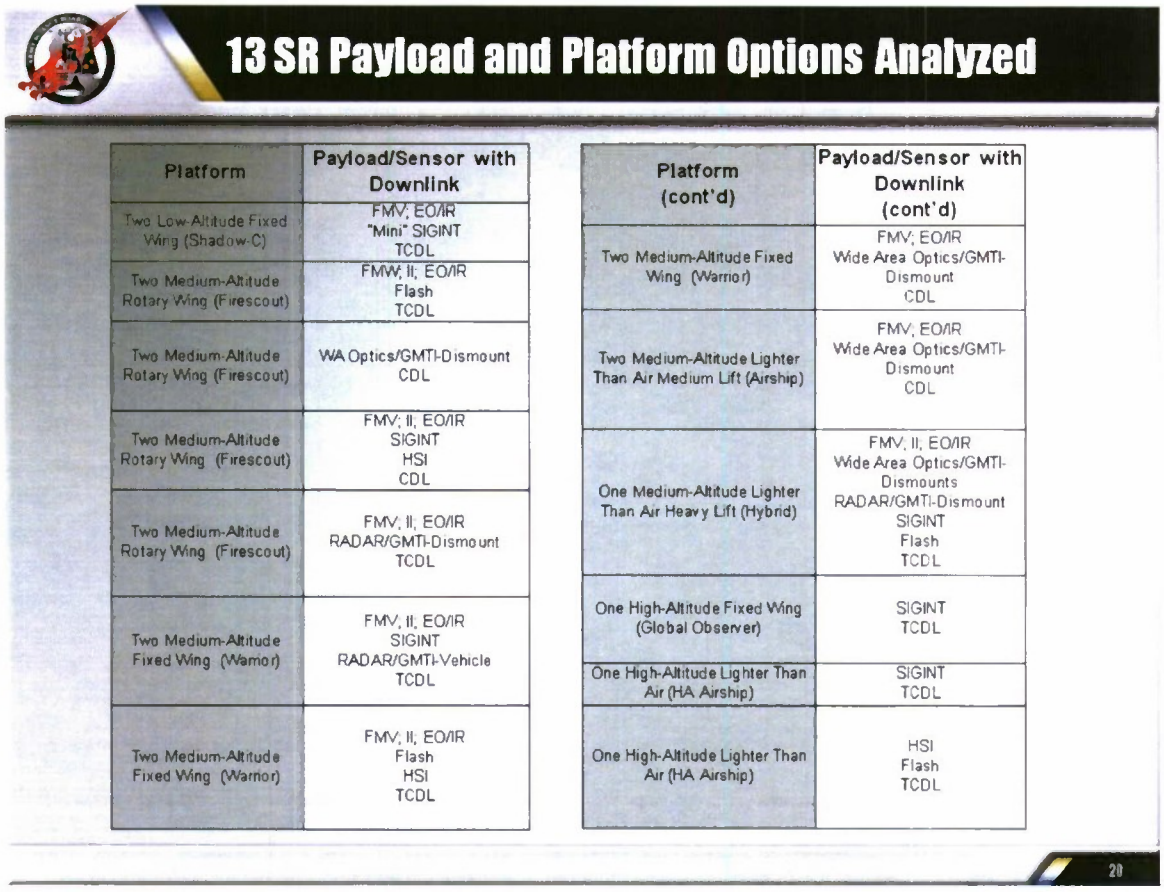
This slide identifies the classes of payloads and platforms used to form payload/platform options for analysis as potential "means" to accomplish the full suite of surveillance and reconnaissance missions identified on the previous slide. Exemplars including legacy and developmental options are shown for each class of payload and platform. Two variations of medium-altitude airships are included. Satellites were excluded from analysis of surveillance and reconnaissance as discussed earlier. Also, every option includes embedded data links (common data link (CDL) or tactical CDL (TCDL)) to support real-time downlinking of data collected.

The alphabet soup of payload exemplars is defined in terms of characteristics and capabilities in the backup slides. The UAVs and airships are also further characterized in the backup slides.

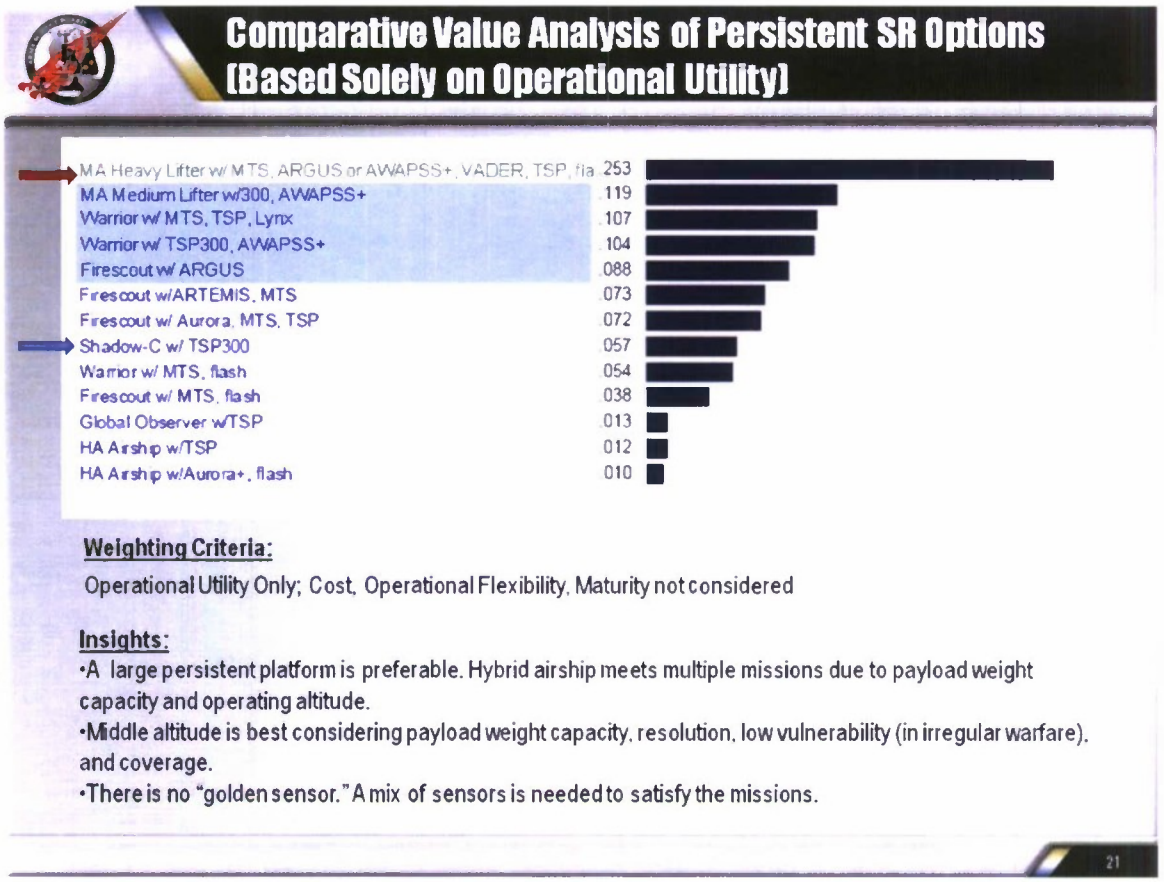


This slide shows the 13 payload/platform combinations chosen for analysis of surveillance and reconnaissance options. All are multiple payload options, and all include integrated data links. The types of payloads selected for the various platforms reflect the desire to deploy complementary sensors to facilitate cross-cucing and thc SWAP capacity of the platforms.

To ensure making realistic comparisons of options for "persistent" communications, we used the following quantities of platform/payload combinations to provide for "as-required" coverage (*not* 24/7 coverage everywhere all the time):

- Long-endurance platforms: I
- All others: 2

Central to the value analysis of each option is the pair-wise comparison of the relative merit of each option to each other option for each criterion as described in the earlier discussion of the AHP model.



This slide shows the results of one special run of the model that gave 100 percent weight to operational utility. It answers the question, "What option is best if cost, maturity, and operational flexibility are not considered?" The answer is clearly the Medium-Altitude Heavy Lifter Airship with a comprehensive suite of sensors as indicated by the green line at the top of the chart with the red arrow. It had a value more than twice as high as the next option.

Other options with high values are shown in the blue cluster.

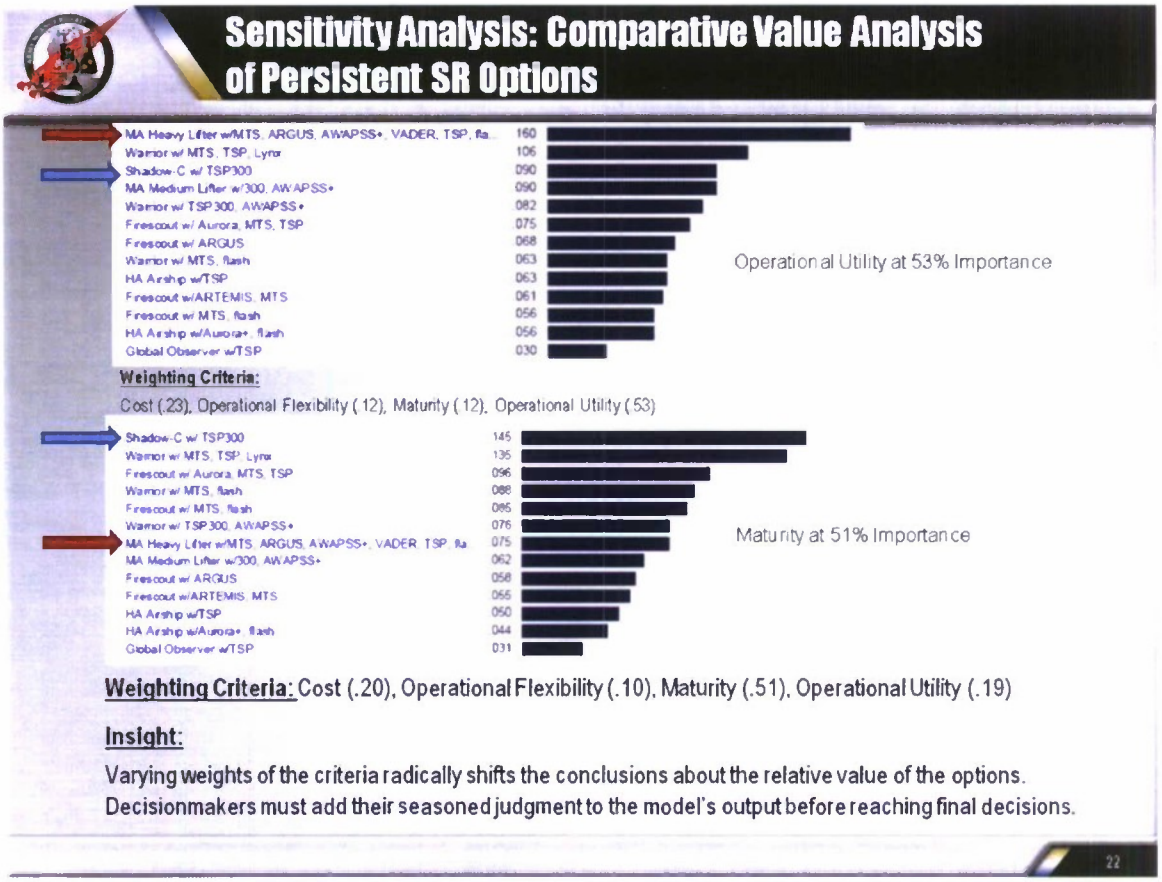
The upper right of the slide shows the values relative values in histogram form.

This demonstrates that large persistent platforms, as expected, have high value. The hybrid airships ranked high because of their endurance, altitude, and capacity to carry multi-mission payloads. Medium-altitude platforms ranked high because of the resolution their sensors can achieve, low vulnerability in irregular warfare environments, and the extent of their area coverage.

At present, there is no "golden sensor," so a mix of sensors is required to satisfy all the missions.

The option marked with the blue arrow in the middle of the list is the Shadow UAV with a mini-sensor package. It is identified as an option that will be tracked and compared to the Medium-Altitude Heavy Lifter as the weights of the criteria are modified in the sensitivity analysis.

Note: Although the shorthand notation on the chart for the blue arrow Shadow-C option identified the sensor as "TSP300," the actual suite of payloads evaluated included miniaturized sensors with full motion video, electro-optic/infrared (EO/IR), signal intelligence (SIGINT), and TCDL data link capabilities. This provided a multi-intelligence package, but it was not as capable as the robust sensor suite on the red arrow option.

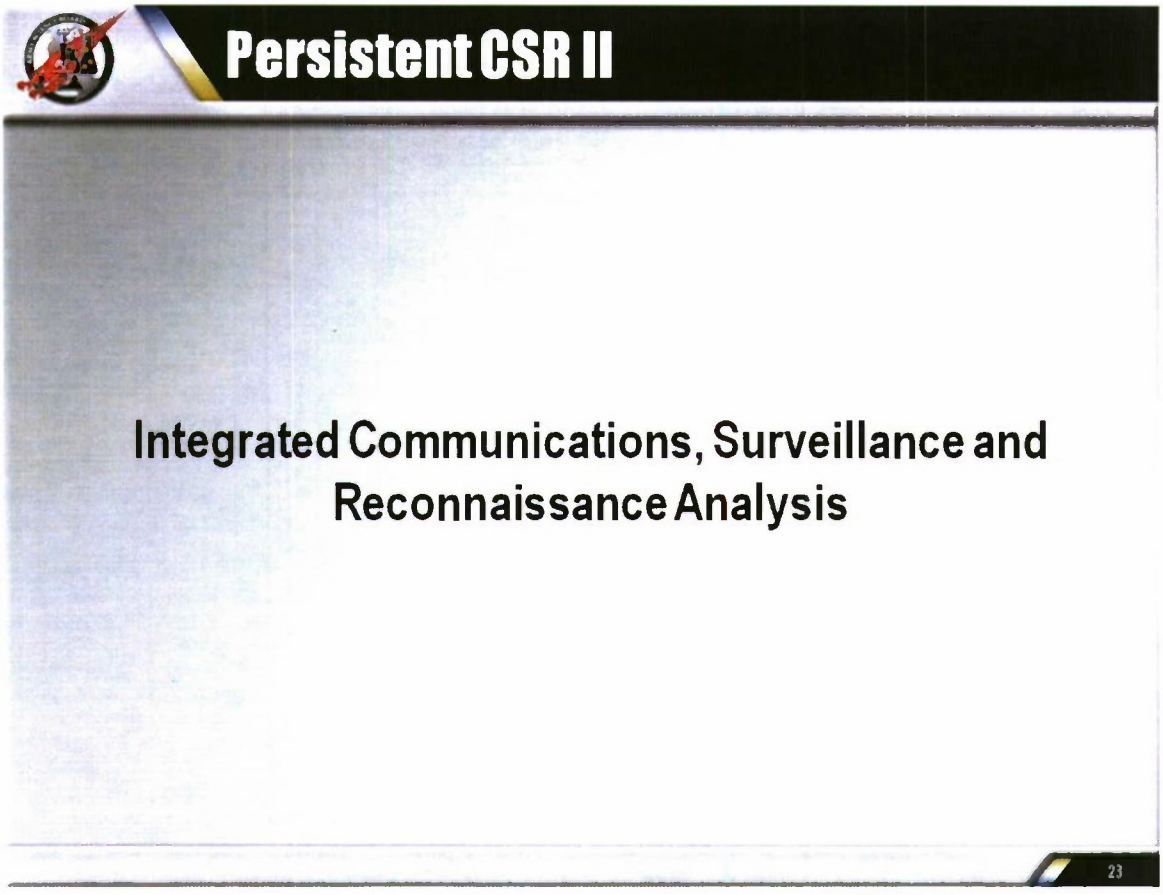


This slide shows how the relative values of the 13 options changed as the weights of the criteria changed.

Looking at the top block on the slide, we see that when we use the baseline weights with operational utility at approximately half the total weight, the Medium-Altitude Heavy Lifter Airship with a comprehensive suite of sensors remained the top-ranked option as indicated by the green line at the top of the chart with the red arrow. However, its value dropped from 0.253 on the previous chart to 0.160 in this excursion. Also, the Shadow-C with the mini-sensor package jumped from 8th place to 3rd place.

In the bottom half of the chart is an excursion with maturity weighted at about half of the total weight and operational utility weighted at about one-fifth. In this case, the Medium Heavy Lifter Airship with a comprehensive suite of sensors (red arrow) dropped to 7th place and the Shadow-C jumped to the top position.

The obvious conclusion is that weights matter, and the results of the value analysis shift dramatically as the decisionmaking criteria change. It is also apparent that the final judgment on which options are preferred requires further detailed comparison of the performance of the payloads and platforms against the specific missions requiring priority support.



The next set of slides shows the elements of analysis for integrated communications, surveillance, and reconnaissance missions and the comparative evaluation of the options

Integrated PCSR Missions Analyzed

Comms Missions

1. Provide High-Bandwidth Network-Node Service
2. Provide Low-Bandwidth Network-Node Service
3. Provide Low-Bandwidth Sensor Data Exfiltration
4. Broadcast Blue Situational Awareness, as in the Satellite Version of Blue Force Tracker
5. Broadcast High Bandwidth
6. Relay Low-Bandwidth Digital, to Include Disadvantaged Users
7. Relay High-Bandwidth Digital
8. Provide Combat 911 Services to Include Search and Rescue and Medical Evacuation
9. Relay Low-Bandwidth Voice
10. Provide Telecom Trunking and Gateway Services
11. Provide Network Situational Awareness

SR Missions

1. Provide Data to Locate, Identify, and Track Counterinsurgents
2. Provide Data to Locate, Identify, and Track Vehicles
3. Provide Data to Locate and Identify IEDs and Ambushes
4. Provide Data to Locate and Identify Enemy Weapons (e.g. Mortars, Rocket Launchers, etc.)
5. Provide Route Reconnaissance
6. Provide Area Surveillance for Force Security
7. Provide Surveillance of Borders

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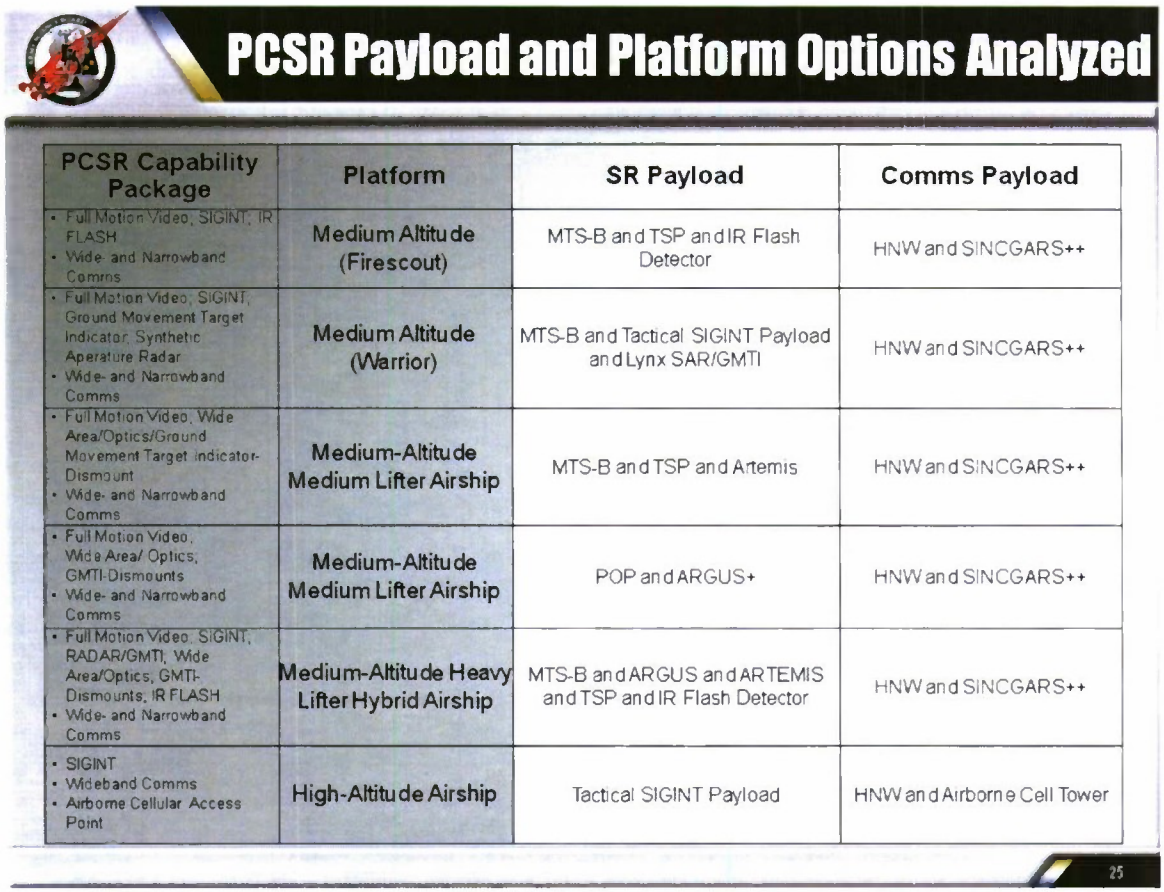
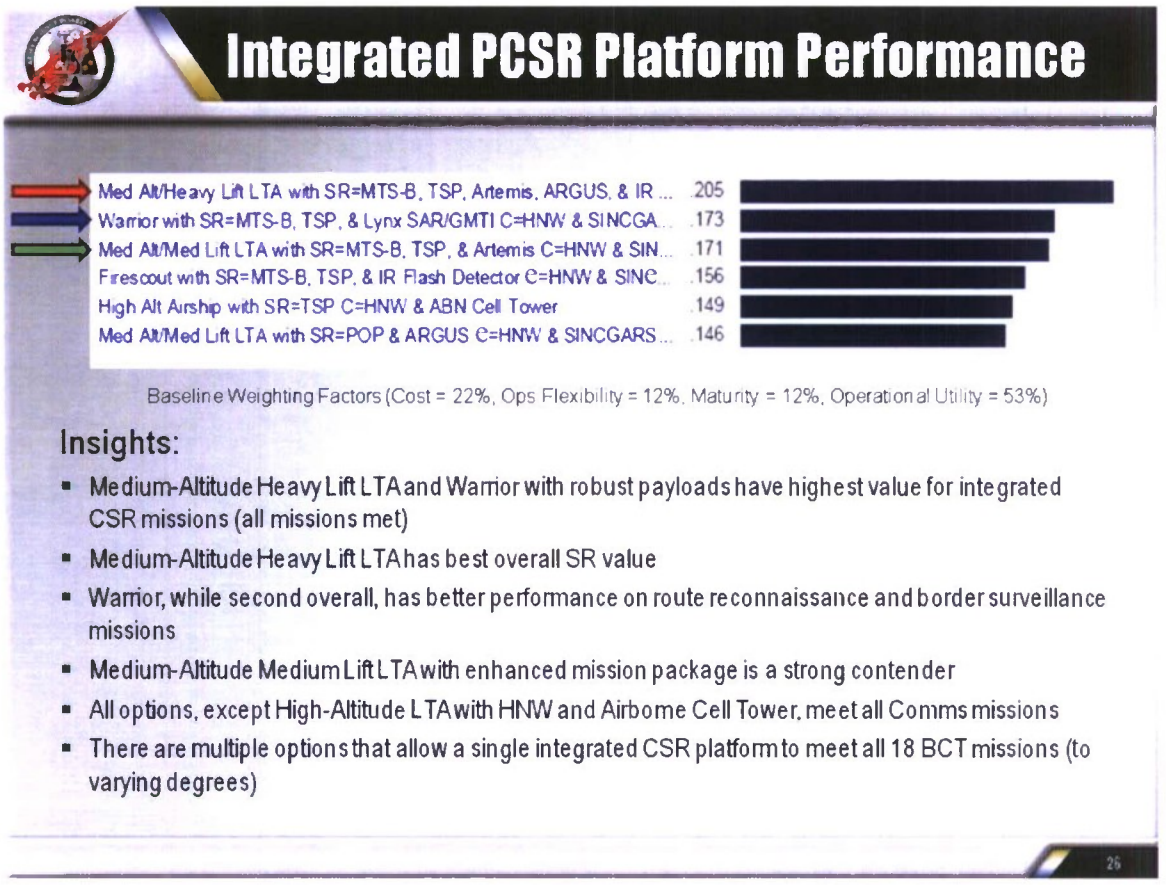
This slide shows the composite suite of 18 PCSR missions that were previously addressed by major mission area.



Six integrated communications, surveillance, and reconnaissance options were evaluated. The first five use medium-altitude platforms equipped with a TCDL, a common set of communications payloads (HNW and SINCGARS++), and different combinations of multi-intelligence surveillance and reconnaissance payloads. The sixth option is a high-altitude airship with a SIGINT payload sensing and a communications payload consisting of HNW and an Airborne Cell Tower.



This slide shows the relative values of the options with the eriteria weighted with the base ease pereentages (i.e., with operational utility at about half, eost about half as important as operational utility, and operational flexibility and maturity eaeh about one-fourth as important as operational utility).

The three top ranked options are highlighted with red, blue, and green arrows to faeilitate tracking in subsequent excursions when the weights for the criteria are varied.

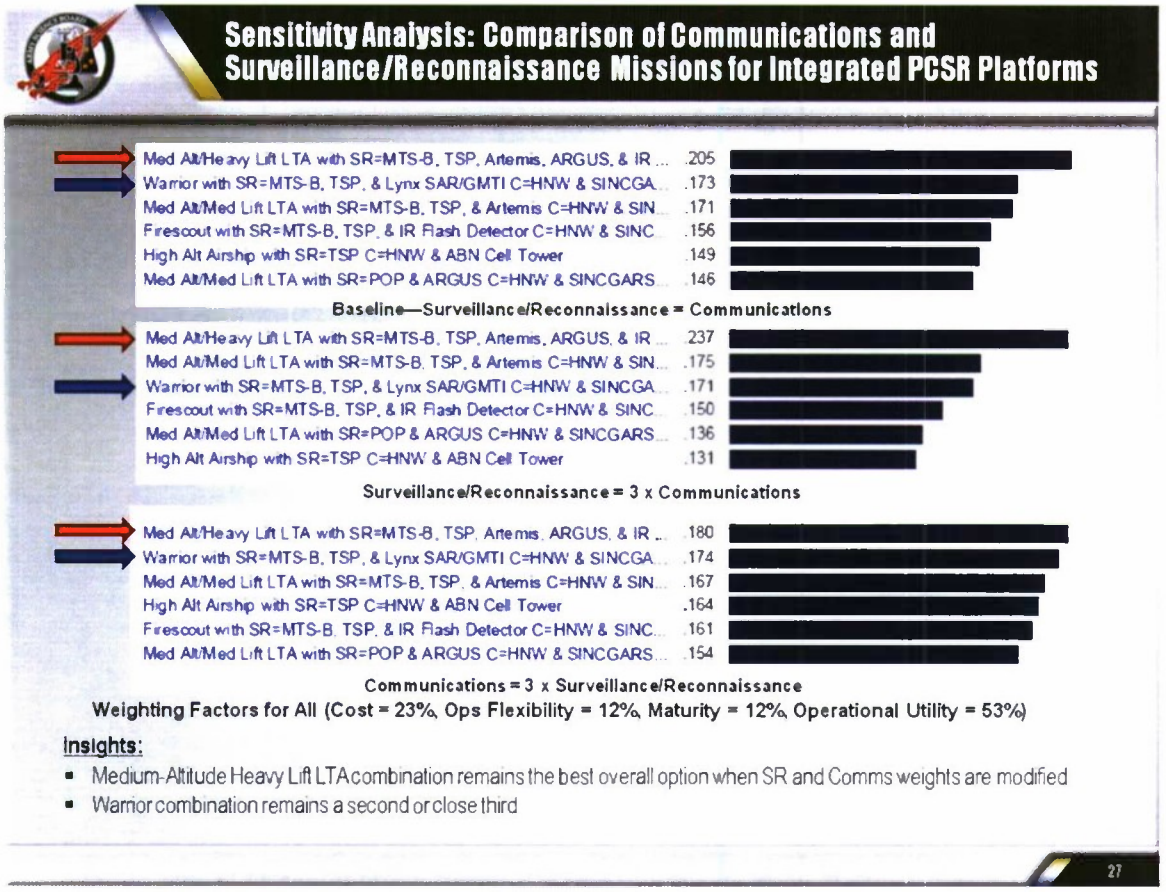
What this run of the model tells us is that the Medium-Altitude Heavy Lift LTA and Warrior with robust payloads have highest value for integrated CSR missions (all missions were met to some meaningful degree).

The Medium-Altitude Heavy Lift LTA has best overall SR performanee, but Warrior, while seeond overall, has better performanee on route reeonnaissanee and border surveillanee missions.

The Medium-Altitude Medium Lift LTA with enhanced mission package is a strong eontender.

All options, exeept High-Altitude LTA with HNW and Airborne Cell Tower, meet all eommunieations missions.

Multiple options allow a single integrated CSR platform to meet all 18 BCT missions (to varying degrees).



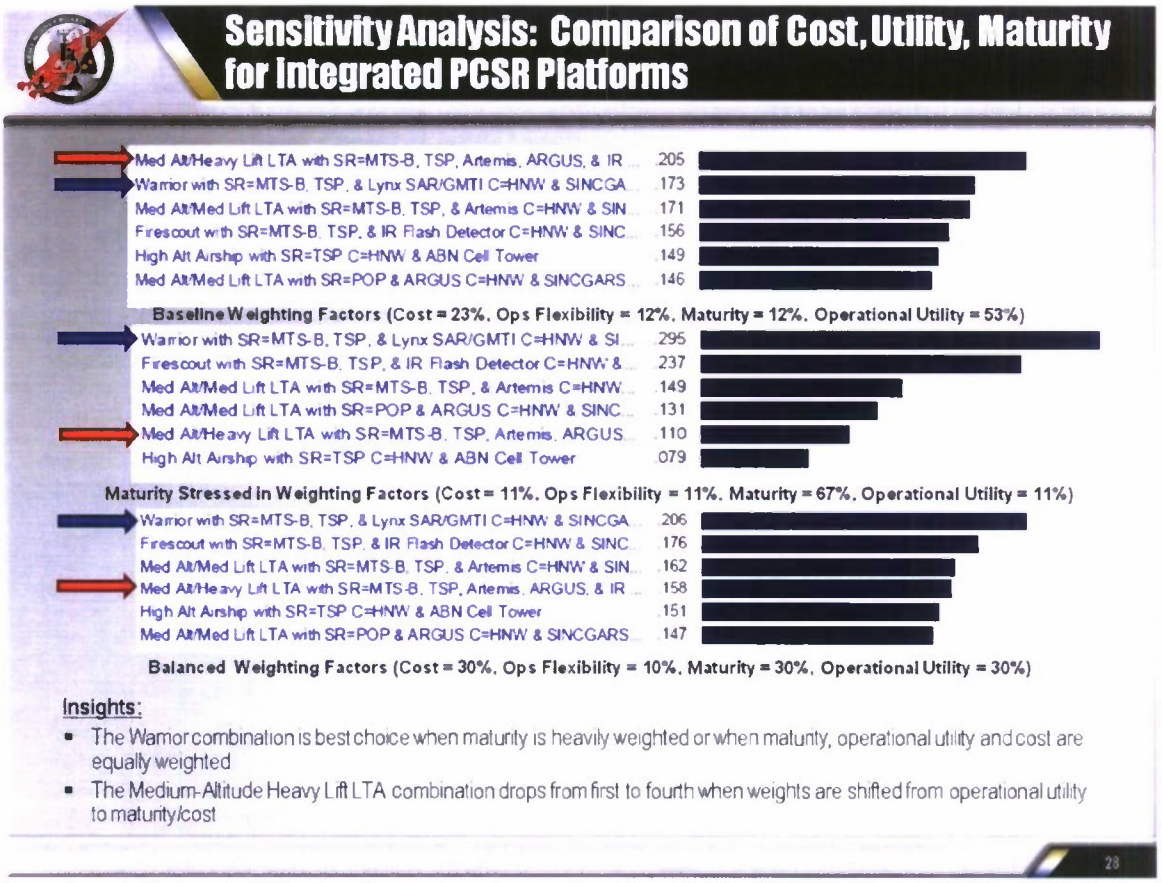
This slide shows the results of sensitivity analysis exeursions with emphasis on traeking the Medium-Altitude Heavy Lift LTA (red arrow) versus the Warrior (blue arrow). The histogram at the top of the chart shows the base-case analysis presented on the prior slide and is repeated here as a referenee point. Within the operational utility eriterion, the communieations missions are weighted as equal to reconnaissance and surveillanee missions.

The histogram in the middle of the slide shows the results when the operational utility criterion is faetored so that the communieations missions are weighted at 25 pereent and reeonnaissanee and surveillanee missions are weighted at 75 pereent.

The histogram at the bottom of the slide shows the results when the operational utility criterion is factored so that the eommunications missions are weighted at 75 pereent and reeonnaissance and surveillance missions are weighted at 25 percent.

The results show that the Medium-Altitude Heavy Lift LTA eombination remains the best overall alternative when communieations and reeonnaissanee and surveillanee weights are modified, although the relative value for the excursion giving higher weights to the reeonnaissanee and surveillanee missions was mueh higher.

In both excursions, the Warrior eombination remained a seeond or elose third.



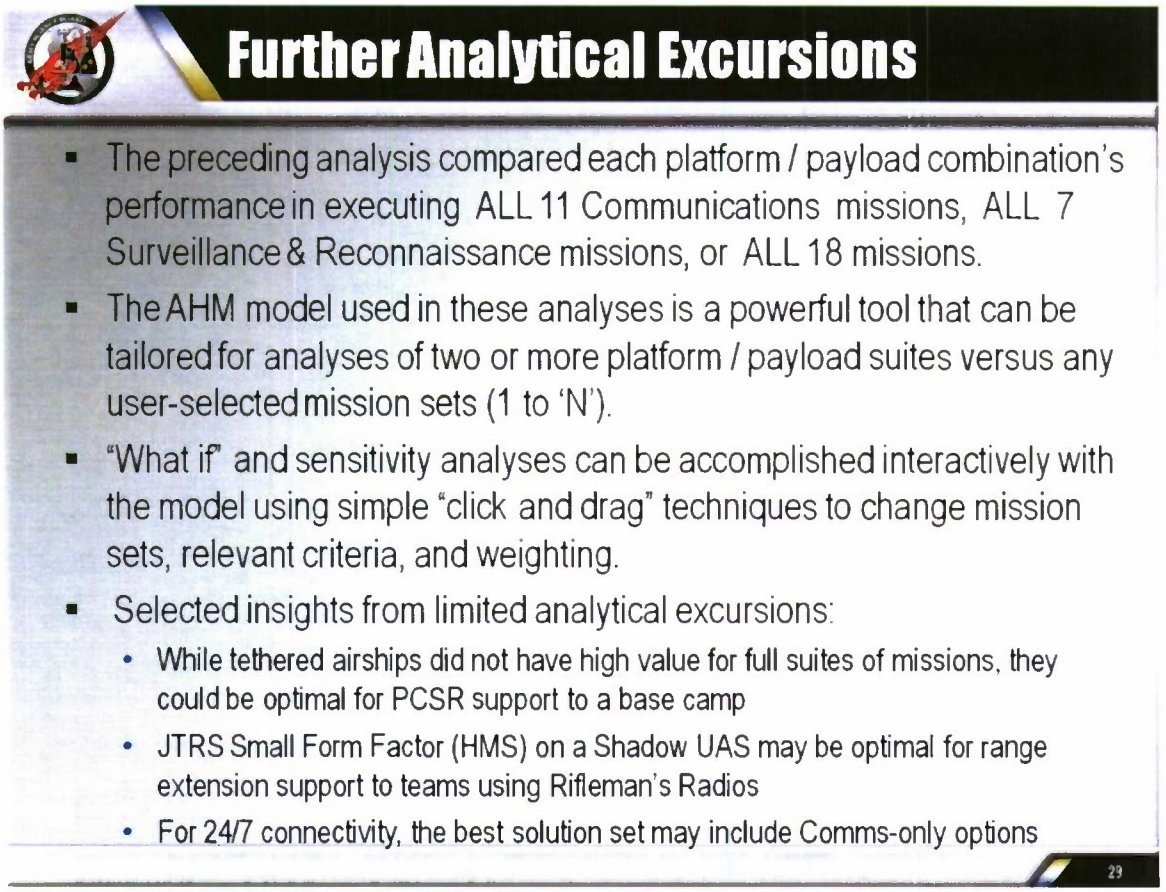
This slide shows the results of another set of sensitivity analysis excursions with emphasis on tracking the Medium-Altitude Heavy Lift LTA (red arrow) versus the Warrior (blue arrow). Once again the histogram at the top of the chart shows the base-case analysis as a reference point.

The histogram in the middle of the slide shows the results when the maturity criterion is weighted heavily (approximately two-thirds). In this case, the Medium-Altitude Heavy Lift LTA dropped from first to fifth, and the Warrior jumped from second to first.

The histogram at the bottom of the slide shows the results when the cost, maturity, and operational utility criteria were equally weighted at 30 percent with operational utility at 10 percent. In this case, the Medium-Altitude Heavy Lift LTA moved up one step from fifth to fourth, while the Warrior remained first by a significant margin.

This leads us to conclude that the Warrior option for integrated communications and reconnaissance and surveillance missions is the best choice when maturity is heavily weighted or when maturity, operational utility, and cost are equally weighted. As indicated above, the Medium-Altitude Heavy Lift LTA option drops from first to fourth when weights are shifted from operational utility to maturity and cost.

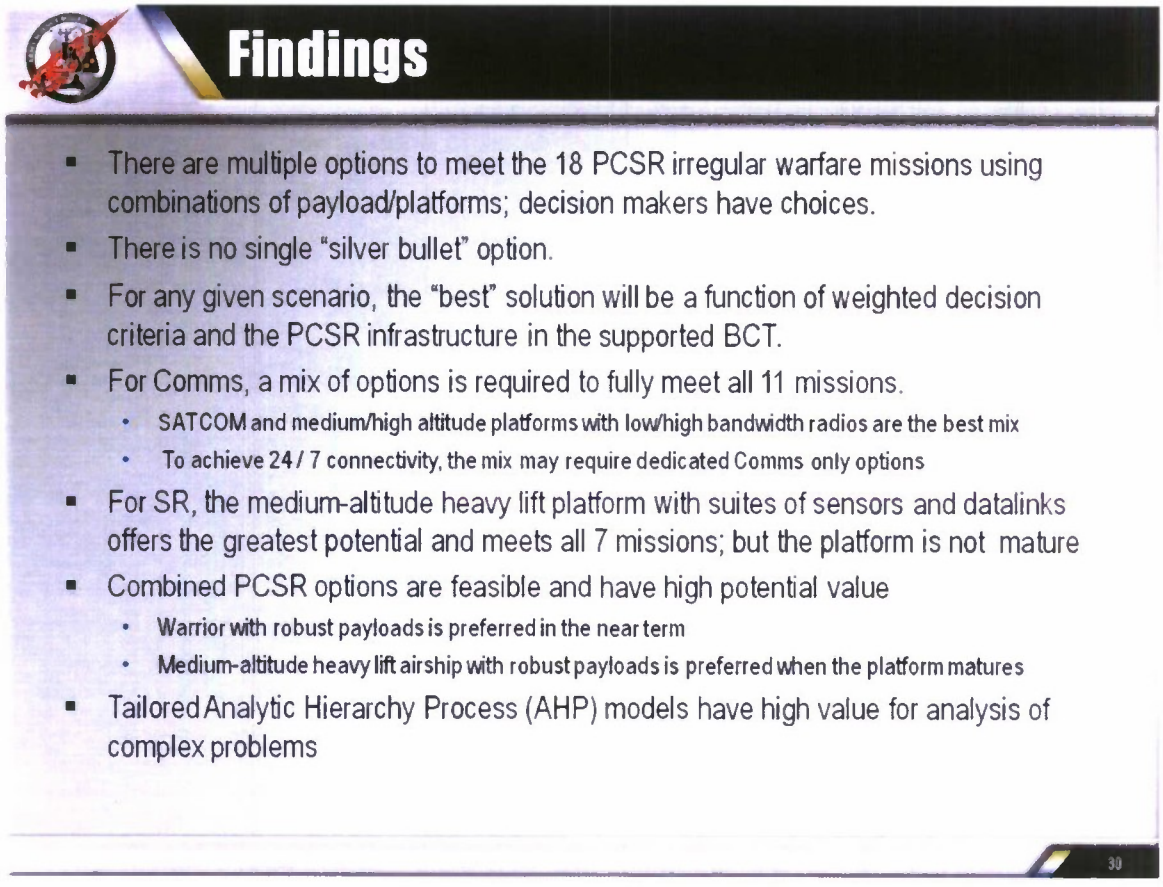
Clearly, the decisionmaker's time horizon and tolerance for risk will be key determinants of the valuation of options. The AHP model has the capacity to show the results of those preferences and the marginal changes in valuation as criterion weights are adjusted.



As indicated in the preceding slides, the model can answer questions relating to how well a series of options can meet a full suite of missions; but the model can be tailored for analysis of any particular PCSR mission or combination of missions.

Single-mission analysis can be conducted interactively with "click and drag" adjustments to criteria weights. Some relevant insights derived from such analysis are:

- While tethered airships did not have high value for full suites of missions, they could be optimal for PSCR support to a base camp.
- JTRS handheld, manpack, small form factor (HMS) on a Shadow unmanned aerial system (UAS) may be optimal for range extension support to teams using Rifleman's Radios.
- For 24/7 connectivity, the best solution set may include communications-only options.



Summary of Findings

Multiple options meet the 18 PCSR irregular warfare missions using combinations of payloads/platforms; decisionmakers have choices.

There is no single "silver bullet" option.

For any given scenario, the *best* solution will be a function of weighted decision criteria and the PCSR infrastructure in the supported BCT.

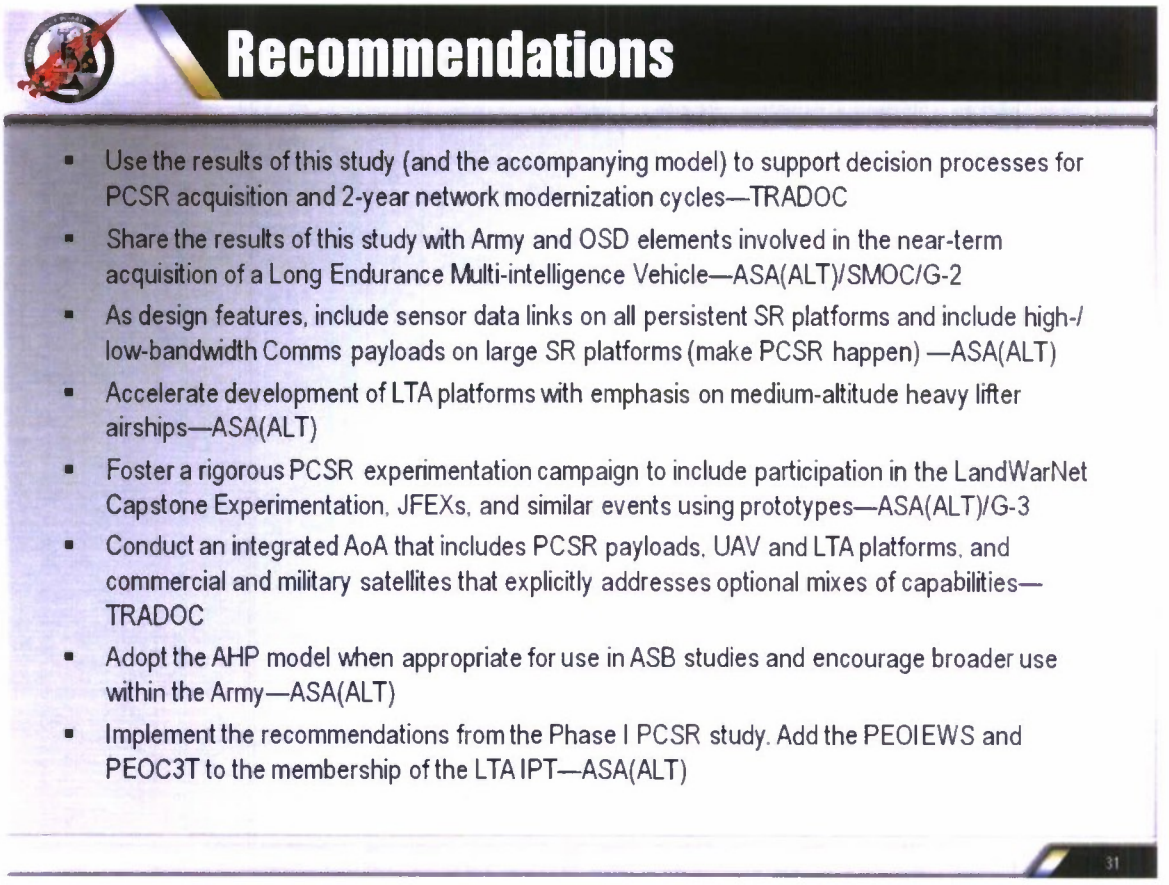
For communications, a mix of options is required to fully meet all 11 missions:

- SATCOM and medium-/high-altitude platforms with low-/high-bandwidth radios are the best mix.
- To achieve 24/7 connectivity, the mix may require dedicated communications-only options (e.g., "Sheriff's net").

For surveillance and reconnaissance, the Medium-Altitude Heavy Lift platform with suites of sensors and data links offers the greatest potential and meets all seven missions; however, the platform is not mature.

Combined PCSR options are feasible and have high potential value:

- Warrior with robust payloads is preferred in the near term.
- The Medium-Altitude Heavy Lift airship with robust payloads is preferred when the platform matures.
- Tailored AHP models have high value for analysis of complex problems



Summary of Recommendations

Each of the following recommendations includes a suggested lead agency for implementation:

Use the results of this study (and the accompanying model) to support decision processes for PCSR acquisition and 2-year network modernization cycles—TRADOC.

Share the results of this study with Army and OSD elements involved in the near-term acquisition of a Long Endurance Multi-Intelligence Vehicle—ASA(ALT).

Include sensor data links as design features on all persistent surveillance and reconnaissance platforms and include high-/low-bandwidth communications payloads on large surveillance and reconnaissance platforms (make PCSR happen)—ASA(ALT).

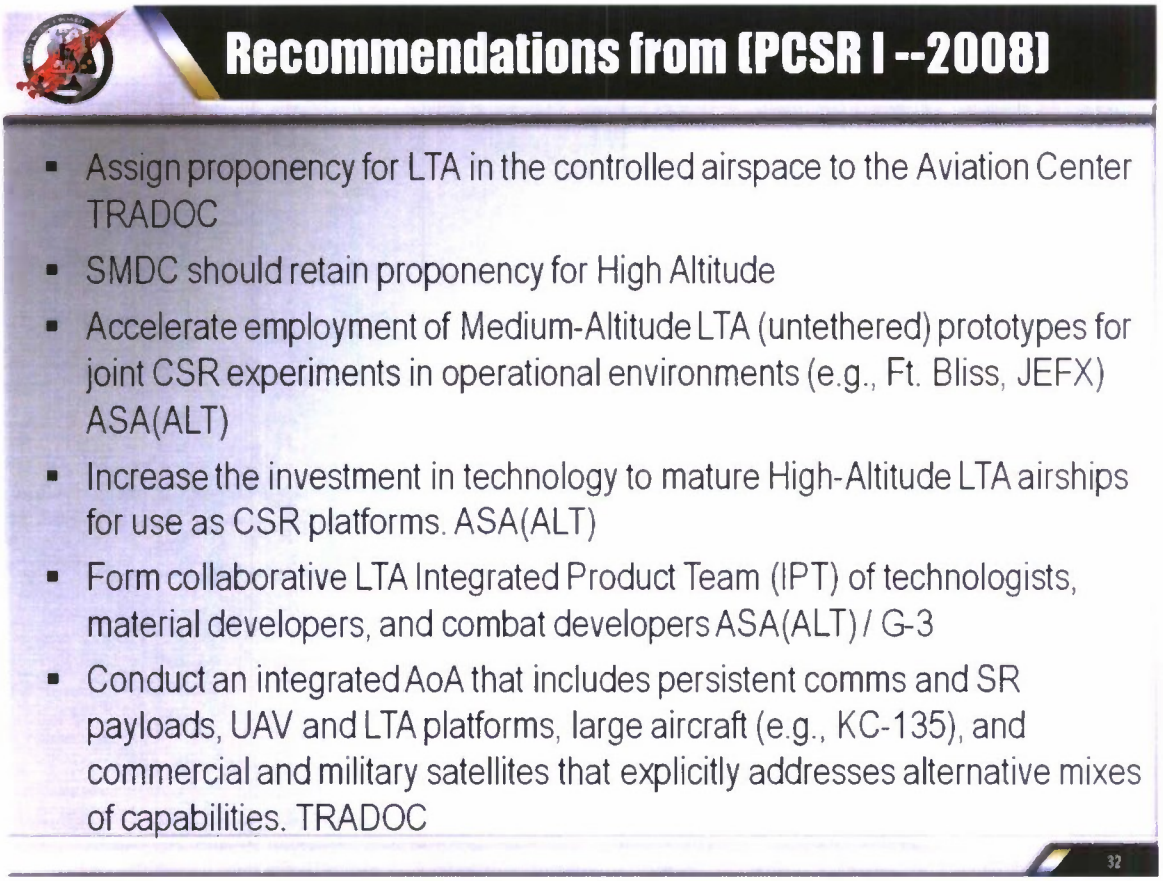
Accelerate development of LTA platforms with emphasis on medium-altitude heavy lifter airships—ASA(ALT).

Foster a rigorous PCSR experimentation campaign to include participation in the LandWarNet Capstone Experimentation, joint forces exercises (JFEXs), and similar events using prototypes—ASA(ALT)/G–3.

Conduct an integrated AoA that includes PCSR payloads, UAV and LTA platforms, and commercial and military satellites that explicitly addresses alternative mixes of capabilities—TRADOC.

Adopt the AHP model when appropriate for use in ASB studies, and encourage broader use within the Army—ASA(ALT).

Implement the recommendations from the Phase I PCSR study. Add the PEO IEWS and PEO C^3T to the membership of the LTA IPT—ASA(ALT).



Our recommendations from the PCSR Phase I study were held in abeyance until the completion of this Phase II report. They are still valid, and we recommend their adoption

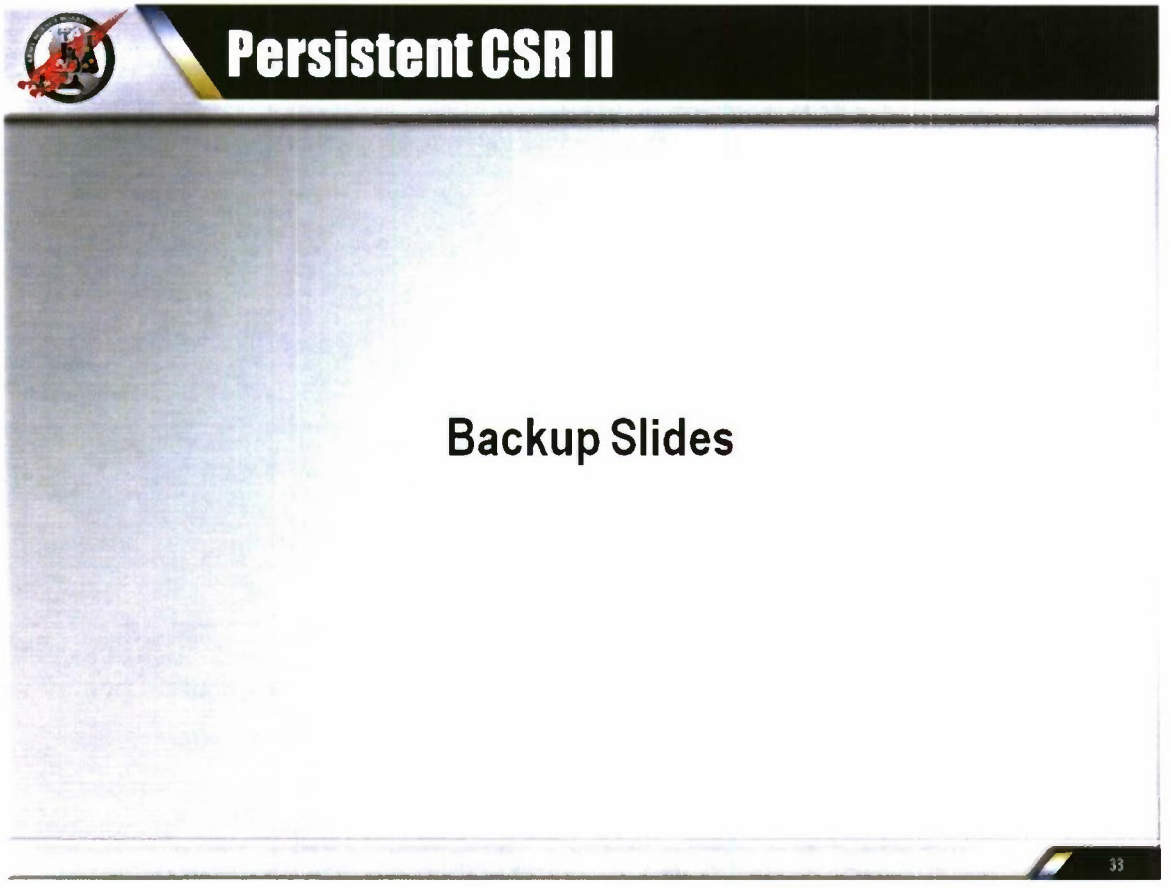
There is currently no proponent for LTA airships in the controlled airspace; this proponency should be assigned to the Aviation Center by TRADOC.

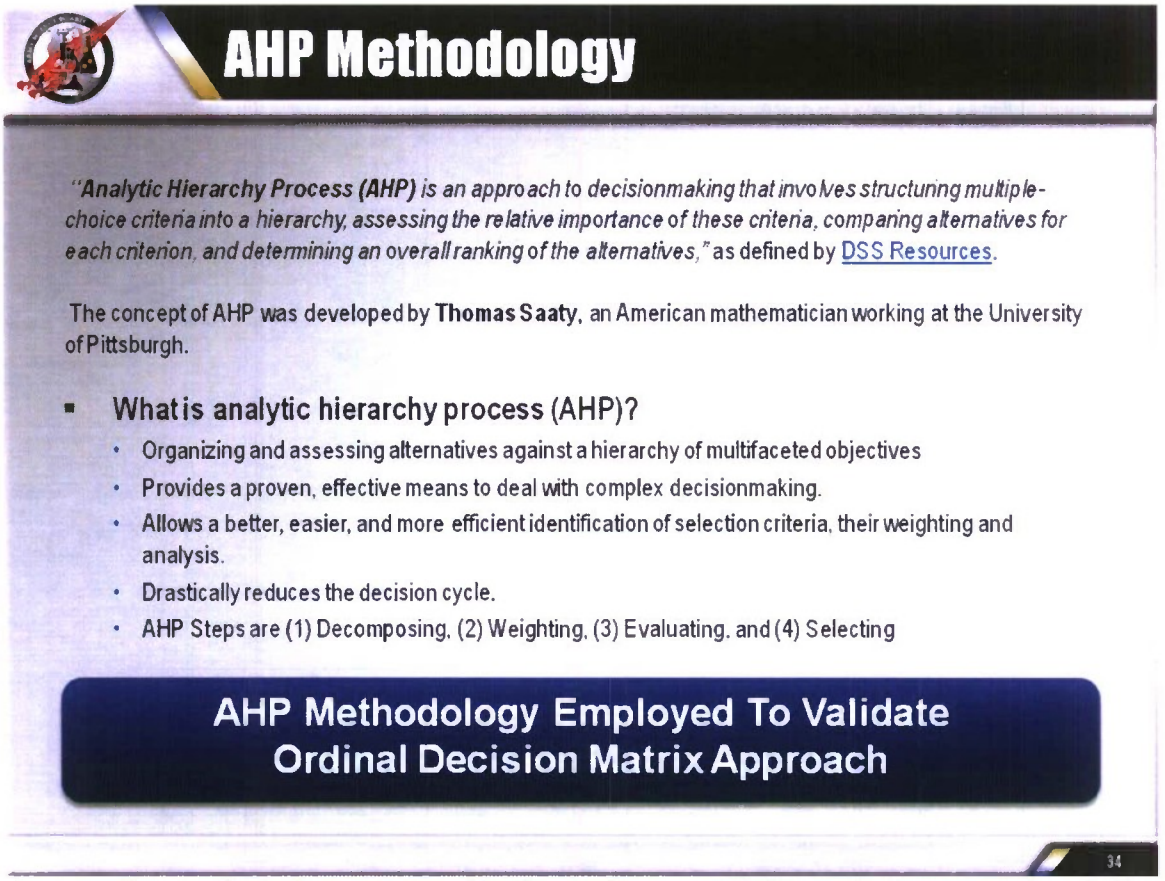
There is great value in continuing to examine the viability of LTA airships in medium-altitude operational scenarios; therefore, accelerate LTA development and operational employment in experiments such as the FCS exercises at Ft. Bliss or the annual Joint Expeditionary Force Experiment (JEFX).

The maturation of high-altitude LTA airships could also be hastened by increased investment; resources in this area need to be increased.

A collaborative organization is needed that will enable the LTA community to support the continued development and fielding of LTA at low, medium, and high altitudes. Accordingly, it is recommended that a collaborative LTA IPT be formed, including but not limited to AMCOM, AMRDEC, PEO Aviation, the Aviation Center, PEO Space and Missile Defense, and SMDC/ARSTRAT.

The Army should conduct an integrated AoA that includes persistent communications and surveillance and reconnaissance payloads, UAV and LTA platforms, large aircraft (e.g., KC–135), and commercial and military satellites. The AoA should explicitly address alternative mixes of capabilities. Inputs from the LTA IPT should be available to assist in conducting the LTA aspects of the AoA.


Persistent CSR II
Backup Slides
33



As part of an analytical process used in the study, a sensitivity analysis was explored. The Saaty Analytical Hierarchy Process (AHP) was used to add confidence to our results. The AHP is a well-known formal method of performing the same types of evaluations as used in this study.

This chart is from a website that provides an implementation of the AHP.

Time constraints would not allow a full implementation of the problem in AHP, so a partial implementation was pursued. The surveillance and reconnaissance mission area was chosen as the example, and the weights and scores were translated into the AHP pairwise comparison. Because of limitations in the software package used, the attributes were reduced from 15 to 16—user SWAP was deleted.

Additionally, the attributes were not arranged in a hierarchy of criteria as provided in AHP. Rather, the flat structure of the existing process was used.

Analytic Hierarchical Structure

Treevie Goal: Recommend a mix of payloads & platforms that afford persistent CSR
- Total Cost of Ownership (L: .250)
  - Procurement / Acquisition Costs (Ratio of Orbit Cost) (L: .333)
  - Maintenance & Operation (L: .333)
  - Infrastructure (L: .333)
- Operational Flexibility (L: .250)
  - Mission Agility (L: .200)
  - All terrain operations (L: .200)
  - All weather operations (L: .200)
  - Airspace management (L: .200)
  - Vulnerability (L: .200)
- Maturity (L: .250)
- Operational Utility (L: .250)

Operational Utility (L: .250)
- Conduct Irregular Warfare Operations (L: 1.000)
  - Conduct Communications
    - Provide (high BW) network-node service (like WNW or maybe HNW) (L: .091)
    - Provide (low BW) network-node service (maybe like EPLRS) (L: .091)
    - Provide low BW sensor data exfiltration (L: .091)
    - Broadcast Blue SA (as in the satellite version of BFT) (L: .091)
    - Broadcast high-BW (like GBI or the xTDLs?) (L: .091)
    - Relay Low BW digital (to include disadvantaged users) (L: .091)
    - Relay high-BW digital (L: .091)
    - Provide combat 911 services (to include S&R and medevac) (L: .091)
    - Relay low BW voice (e.g. SINCGARS or Soldier Radio and other disadvantaged users) (L: .091)
    - Provide telecom trunking and gateway services (L: .091)
    - Provide network situational awareness (L: .091)
  - Conduct surveillance and reconnaissance
    - Provide data to locate, track, classify, & identify dismounted counterinsurgents
    - Provide data to locate, track, classify, & track vehicles
    - Provide data to locate and identify ambushes against dismounted patrols
    - Provide data to locate and identify enemy weapons (mortars, rocket launchers, etc)
    - Provide route reconnaissance (detect and prevent IEDs attacks and ambushes)
    - Provide area surveillance for force security (protect remote outposts)
    - Surveil borders (deny sanctuary)

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AHP Methodology

Assess the utility of the AHP models in conducting analyses of complex analytical and decision processes and provide insights and recommendations

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AHP Methodology and Recommendations

- AHP model shows good utility and flexibility in the assessment of multiple criteria alternatives. It is relatively easy to learn.
- ASB should acquire the software for an AHP model and have it available for use by ASB study teams
- ASB needs to train staff and support personnel in the use of the AHP model so that capability becomes part of the resident ASB staff

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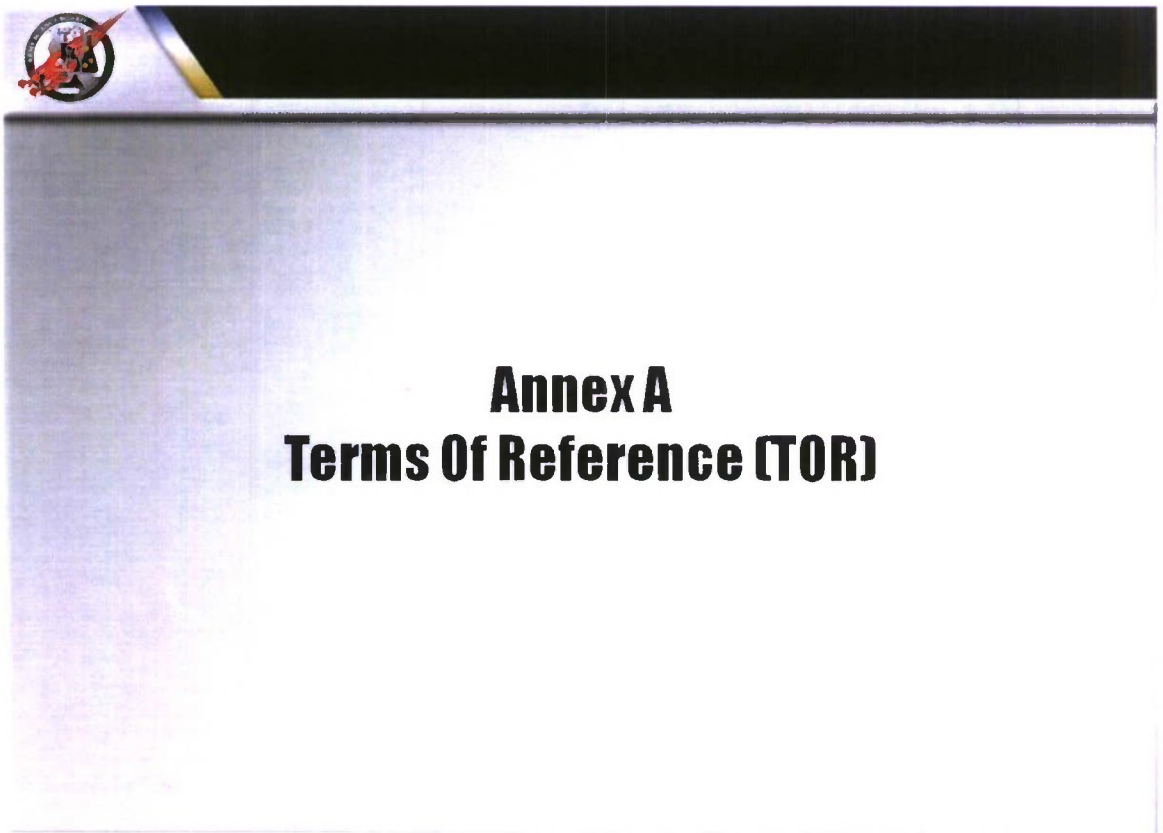

Annex A
Terms Of Reference (TOR)

Terms Of Reference (TOR)

Persistent CSR (Communications Surveillance and Reconnaissance) for the Current and Future Force —Phase II 2/23/09

Current studies of the military operations in both OEF and OIF as well as predictions concerning similar future operations indicate a need for better (increased or more efficient) communications coverage as well as enhanced sensor capability for reconnaissance and surveillance. "Better" and "enhanced" can assume a broad range of meanings depending on the situation and echelon involved, however, it is generally accepted that one goal relates to persistence of communication and sensing, another relates to clarity or fidelity, and a third relates to available bandwidth. In three previous ASB studies, two involving Intel and one involving Land War Net, persistent CSR contact among all echelons has been suggested and persistent overwatch and surveillance has been sought. These improvements are especially necessary in order to maintain situational awareness and reachback for supporting fires as well as providing knowledge of location and condition of friendly and enemy units. Further, information requirements of forces (whether large or small) in imminent contact with enemy forces demand nearly continuous, timely, information flow, better insuring the safety of forces and increasing the margin of victory.

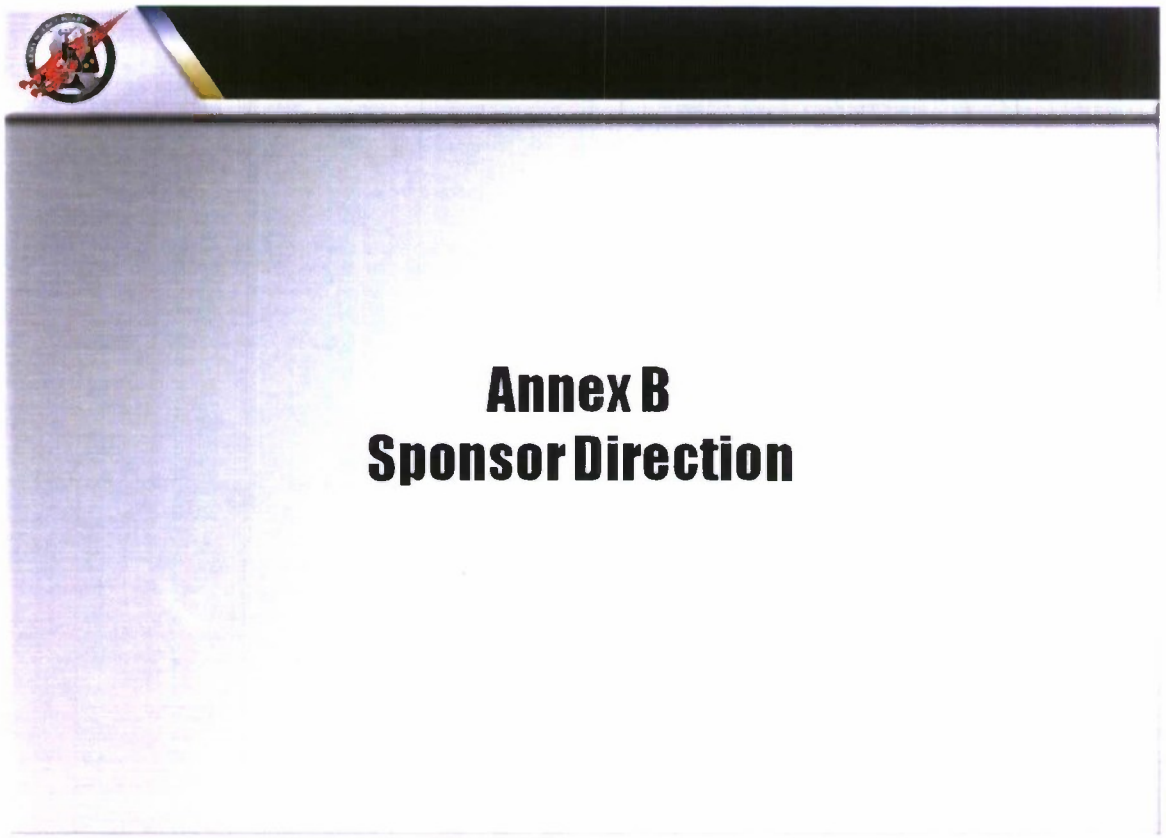
Expanding situational awareness and facilitating communications among units allows all types of modular brigades to enjoy greater mobility especially if communications can be maintained while "on-the-move" and in austere environments. Such capability will also improve reachback for support from non-organic fires and intelligence.

Obtaining the best balance between performance, mobility and supportability of communications and sensing capabilities is critical to enhancing the effectiveness of combat units at every level of command. Thus, organizing appropriate combinations of communications equipment and sensors is a focal point of this study in support of the operational concepts for the current and future forces. In some cases, combinations of highly elevated platforms are most efficient in providing necessary capabilities. In other cases, ground based sensors might be the most useful. In any event, a systematic approach to developing a model for communications and sensing using combinations of available assets is necessary to utilizing those assets in the most efficient fashion.

The goal of this follow-on Phase II study is to suggest a concept and structure for best use of CSR assets and their payloads, including reporting on:

1. What payload capabilities are possible from Space-based, "Near-Space" based, High-Altitude Long-Endurance UAV-based or Airship-based platforms reviewed in Phase I?
2. How do these payload capabilities compare to those available on lower altitude UAVs as well as ground-based and other assets?
3. How does one trade off the benefits and weaknesses of each type of asset?
4. To what degree can both the current and the future forces increase mobility and sustainability through integration and systematic use of such assets?
5. To what degree do such payloads decrease the logistics and support burden for sustained operations?
6. How does cost of each type of payload compare?

Additionally, the team will assess the utility of AHP models in conducting analyses of complex analytical and decision processes and provide insights and recommendations to the ASB Red Team.



Annex B
Sponsor Direction

Sponsor Direction

Sponsor is asking for a next step from the platform study

- Comms is the Army's greatest shortfall; however, focus on both Comms and SR.

- Study targets are TRADOC, ARCIC, G2, G3 and G6. Sponsor introduced high altitude platforms at Army Space Conference, and got the giggle factor. HA platforms have some very attractive platforms. Weight the study a bit more on HA platforms. Space-based capability could be value added.

Sponsor Direction – (continued)

- How do you measure taskability for the operational commander?
- Do not weight C or S or R—balance as in the Phase I effort completed last year
- Ft. Bliss is struggling with JLENS—is it worth it? They are also fighting perceptions on their LTA. LTA was an interesting platform the ASB group saw last year. The problem is the weight factor and the logistic tail. Going to Ft. Bliss and visiting the FCS FFID will be good.
- Look at JCTDs as source of commercial technology for mature IP router that could be deployed on a local airship. It will be helpful for ASB group to investigate.
- Time frame is still 3–5 years; the clock started last year.

Updated Guidance: In conjunction with the DoD ISR Surge, assist the G-2/SMDC in conducting a baseline assessment of Lighter Than Air (LTA) capabilities

Annex C
Bibliography

Bibliography Introduction

- The Persistent CSR II study team compiled a large number of references in the course of the study. These documents supported the analysis and provided ready reference to help answer questions and to learn more about systems and capabilities.
- The bibliography is organized in the same manner as the visits made by the Persistent CSR II team. The visit schedule lists the trips. Following this "table of contents" is a detail of each visit, including the titles of the presentations provided to the Persistent CSR II team during their visit. The electronic copy of the briefing can be found in the ASB CSR II Knowledge Center, filed under the title of the trip or visit.
- Should you have any questions, please contact the ASB Persistent CSR II Study Manager, Ms Anorme Anim.

ARMY VISITS

- SMDC/ARSTRAT
  - High Altitude Payload, Boston—Mar 25
  - TacSat-3 & 4 Update, Pentagon City—Jun 9
- G-2, Pentagon—Mar 19, Apr 6, Apr 17
  - Tactical Airborne Radar Technical Parameters
  - ISR Surge Documentation
  - PA&E Cross-Cutting Study
- ASB LWN Study, Summer Session—Jul 17
  - Army Global Network Enterprise Construct (GNEC) by CIO/G-6
  - OEF Initial Observations by G-3/5/7
  - LWN III Overview
  - 16 JUN 09 GOSC ICT

ARMY VISITS

- TRADOC HQ, Telecon - Mar 4, Ft. Monroe - May 19
  - Initial Capabilities Document For Aerial Layer Network Transport
  - High Altitude Enabled Capabilities Assessment
  - High Altitude Enabled Capabilities Assessment Operational Concept
  - SHADOW CRP-L
  - NT CBA Schedule
  - Aerial Sensor and Relay Capabilities Based Assessment

ARMY VISITS

- CECOM/CERDEC, Ft. Monmouth – April 28-29
  - ISR Architectures
  - TRACER
  - FORESTER
  - VADER
  - ARTEMIS
  - Sledgehammer
  - Remote Monitoring System (RMS)
  - Integrated Tactical Airborne Deployable System (ITADS)
  - Stargrazer
  - Electronic Support to the Future Force (ESFF)
  - MR-TCDL
  - I-ASE/BIAS Battle-space integrated aircraft survivability
  - TSP
  - WIN-T Increment 3 comms range ext
  - FCS NAIL Sensor Analysis Tool
  - Beyond Line of Sight Tactical Comms Relay (BTCR)
  - Antennas and CJSMPT
  - PMC4ISR OTM
  - Intelligence Communications Requirements to WIN-T/JTRS

ARMY VISITS

- Night Vision Lab, Ft. Belvoir – May 20
  - NVESD Technologies for Persistent Surveillance
  - Tactical Aircraft to Increase Long Wave Infrared Nighttime Detection (TAILWIND)
  - *D.CER 2010.01 / Advanced Common Sensor Payload*
  - Ground-to-Ground Hyperspectral Sensing
  - Airborne Hyperspectral Systems
  - Tower Mtd Sensor Technology for Expeditionary Persistent Surveillance
  - Constant Hawk Night Advanced Wide Area Surveillance System (AWAPSS)
  - CH-A Airborne Mission Payload
  - EO Sensor Suite
  - Autonomous Real-time Ground Ubiquitous Surveillance - Imaging System (ARGUS-IS)
- AMCOM, Summer Session – July 15
  - Unmanned Airships Can Address Current Battlefield ISR & Communication Shortfalls

OTHER VISITS

- Draper Lab, Boston – March 13
  - Defense Science Board Report on Integrating Sensor – Collected Intelligence
- Lincoln Lab, Boston – March 14
  - Communications and Information Technology Overview
  - Lasercom Support of Tactical ISR
  - Advanced Tactical ISR and Communications Technologies
  - ISR Systems and Technology Overview
  - Advanced SIGINT Receivers
  - SAR Change Detection for Persistent Surveillance
  - Decision Support for ISR Systems

OTHER VISITS

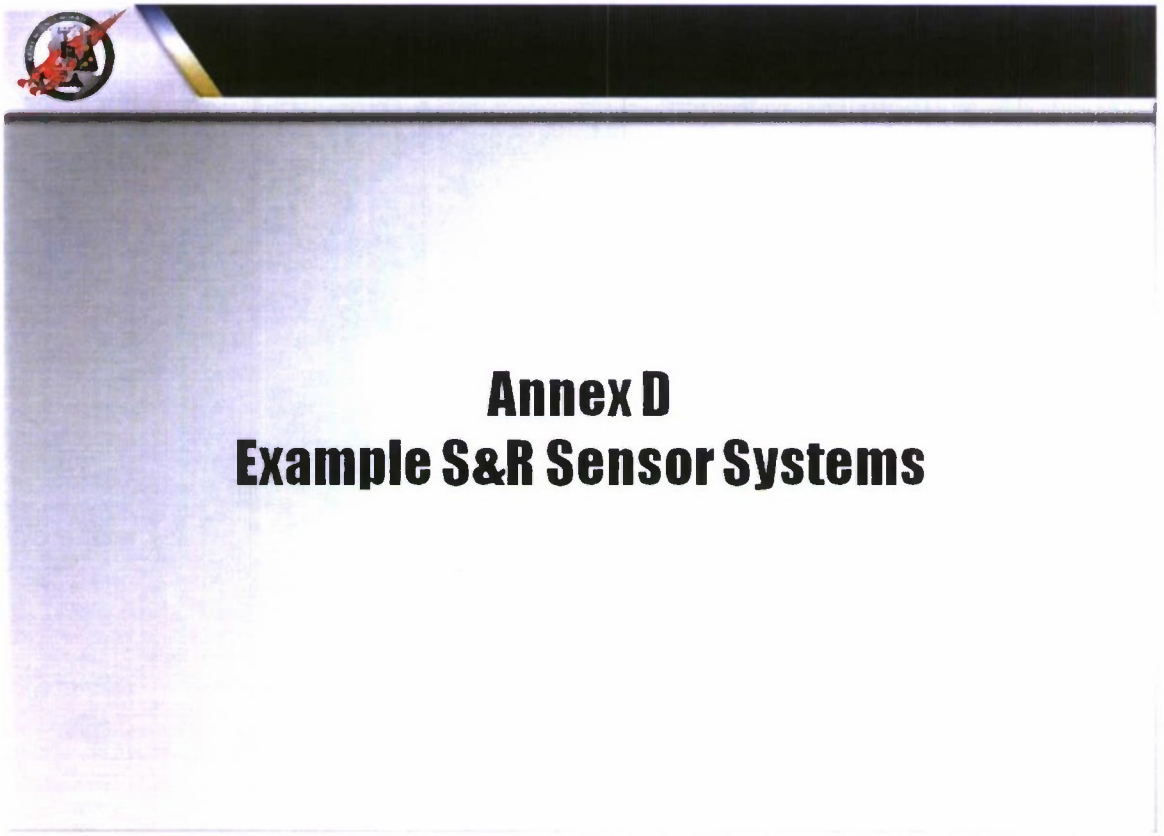
- OSD, Pentagon – April 15
  - SECDEF ISR TF Initiatives of Interest
  - JCTDs Addressing Persistent ISR
- DARPA
  - DARPA ViRAT
  - VULTURE
  - Optical RF Communications Adjunct ORCA
  - Mobile Ad hoc Interoperability Network GATEway (MAINGATE)
- RAND, Pentagon City – April 15
  - Capabilities-Based Analysis of UAV Sensors for Afghanistan

INDUSTRY VISITS

- AeroEnvironment
- BAE Systems
  - Spectral Infrared Remote Imaging Transition Testbed (SPIRITT)
  - Airborne Wide Area Persistent Surveillance Sensor (AWAPSS)
  - AURORA & PASS Sensors
  - ISR Capabilities
  - Sensor Systems, Identification and Surveillance
- General Atomics
  - NightHawk Wide Area Persistent Surveillance

INDUSTRY VISITS

- Harris Corporation, Summer Session – Jul 14
  - Highband Network Waveform for Airborne Networks
  - WIN-T Overview
  - MR TCDL
- ISL Corporation, Summer Session – Jul 15
- Lockheed Martin, Pentagon City – Apr 15
  - HUAV Hybrid Unmanned Air Vehicle



Annex D
Example S&R Sensor Systems

Example S&R Sensors (cont.)

Narrow FOV – POP 300

- 640 x 480 Thermal Imager (3 – 5 μm)
  - FOVs – 29 x 22° ; 9.2 x 6.9° ; 2.3 x 1.7° ; 1.15 x .86°
- Color CCD with near IR capability
  - FOV – 1.0 x 22.5°
  - Zoom – 1:45
- Dimensions - 10" x 15"
- Weight – 35 Lbs
- Power – 120 watts

Example S&R Sensors (cont.)

SIGINT:

The Tactical SIGINT Payload (TSP):

Provides BCT with overwatch and SIGINT system which detects, locates and geolocates on RF entites throughout AO in near real-time

TSP – Weight < 100 Lbs

Size < 2 Ft

Power < 1 KW

TSP – Lite – Weight < 50 Lbs

Example S&R Sensors (cont.)

Wide-area coverage:

Advanced wide-area surveillance system – AWAPSS

- Area coverage – 8 km diameter @ 18 kft
- GSD: < 1 to 1.5m (IR); < 0.75 to 1.1m (V)
- Data rate: 470 MB/sec (EO & IR)
- SWAP: sensor & turret – 204 Lbs/471 watts

Autonomous real-time ground ubiquitous surveillance – imaging system – ARGUS-IS

- IMINT EO System
- 65 steerable video streams
- Compressed data to fit CDL
- Area coverage – 7 km @ 20 kft
- GSD: 15 cm @ FOV center
- Global Moving Target Indicator for vehicles
  - Report locations in real-time
  - Keep history of moving targets

Example S&R Sensors (cont.)

Radar

LYNX SAR/GMTI

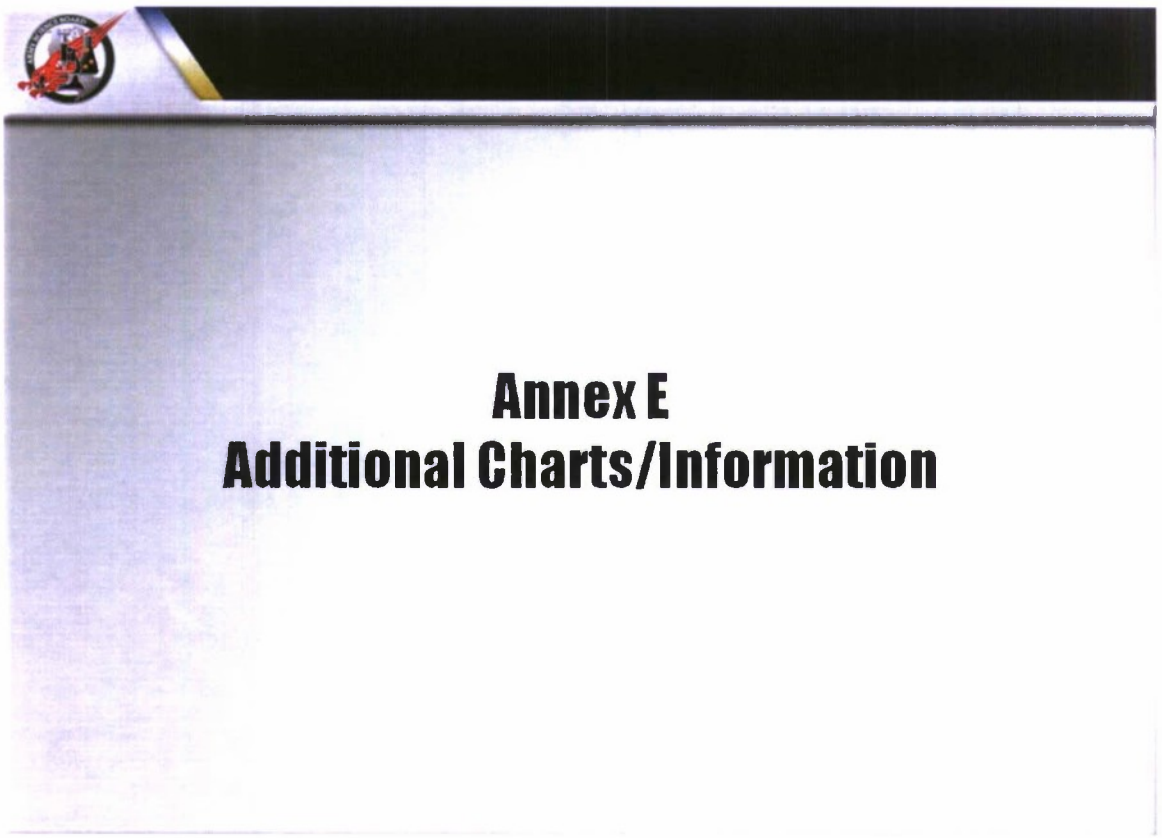
- Detection of vehicles
- Designed for UAS (Predator, Firescout)
- Resolution – 0.3 to 3m in stripmap mode
- 0.1 to 3m in spotlight mode
- SWaP – 52 Kg
- Operations: Identified AOI in stripmap mode then switch to spotlight and zoom up to 0.1m resolution
- GMTI mode – 10 to 70 Km/hr
- Area Coverage: 25 Km2/minute @ 1 meter
  - 300x170 meters 2/minute @ 10 cm

ARTEMIS SAR/GMTI

- GMTI detection of dismounts: 0.5m/sec
- Detection of vehicles: 2m/sec
- 10 Km/ accuracy 100m
- 3 Km/ accuracy 30 m
- SAR: Resolution – 1m stripmap mode

1m spotlight mode

Accuracy - < 25m @ 15Km



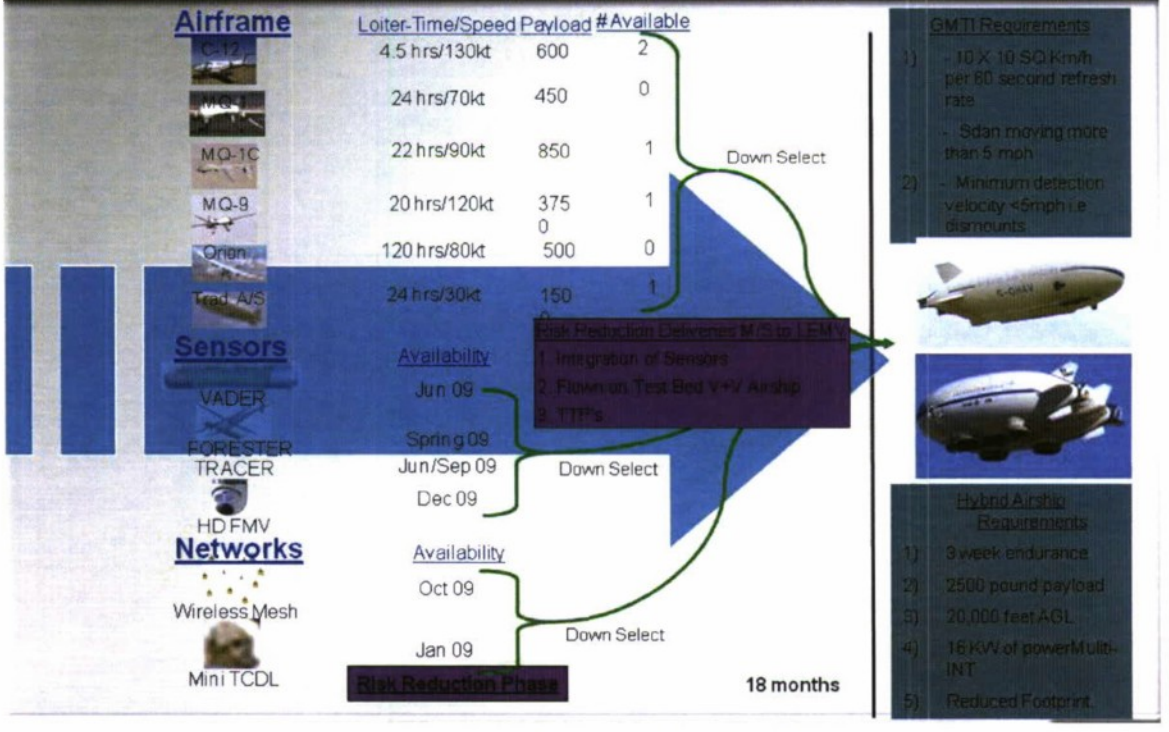
Annex E
Additional Charts/Information

SR Platform Capacity

Platform	Weight Cap (lbs)	Payload/Sensor	Sensor and Telemetry Weight (lbs)
Shadow-C	91	POP 300 and "Mini Tactical SIGINT Payload"	80
Firescout	500	MTS-B and MWIR/Flash Detection	350
Firescout	500	ARGUS	590
Firescout	500	Aurora and MTS-B and Tactical SIOINT Payload	538
Firescout	500	ARTEMIS and MTS-B	470
Warrior	575	MTS – B and Lynx SAR/GMTI and TSP	560
Warrior	575	MTS-B and MWIR/Flash Detection and Aurora HSI	385
Warrior	575	POP300 AND ARGUS	500
MA Medium Lifter	500	ARGUS and POP 300	500
MA Heavy Lifter	2500	MTS-B and ARGUS and ARTEMIS and Tactical SIOINT Payload and MWIR/Flash Detection	1935
Global Observer	400	Tactical SIGINT Payload	165
HA Airship	400	Tactical SIGINT Payload	165
HA Airship	400	Aurora HSI and MWIR/Flash Detection	245

500 lb payload capacity is too small. We could not fill up a 2500 lb payload. The sweet spot is somewhere in the middle.

Task Force Alternative - Multi-Int Sensor Integration GWOT Persistence Path



Warrior UAV

Mission: To provide dedicated mission configured, UAV support to the Fires and Battlefield Surveillance Brigades, Brigade Combat Teams (BCTs), and other Army and Joint Force units based upon the Commander's priorities.

Characteristics / Description:

- Length: 28 ft
- Wing Span: 56 ft
- Max GTOW: 3000 lbs with growth plan to 3600 lbs
- Loiter Speed: 60-75 kts
- Max Speed: 150 kts
- Range Mission Mode: 350 km
- Range W/Relay: 500 /1200 km (ADR/SATCOM)
- Takeoff Distance/Landing: 3800 ft @ 9k ft DA
- Service Ceiling: 29,000 ft
- Max Endurance w/250 lbs payload: 40 hours
- Hardpoints rating: 2 @250 lbs, 2@500 lbs

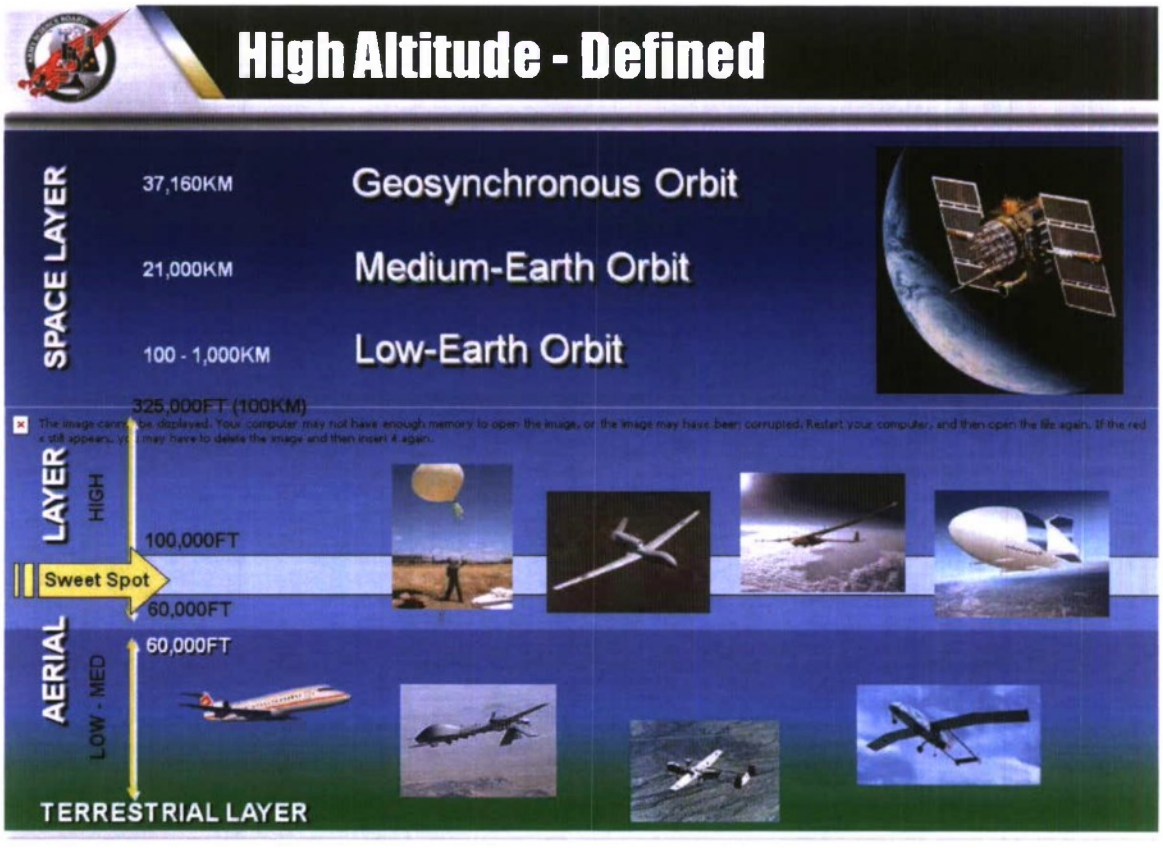
Mission Requirements:

- Near real time information /Dynamic re-tasking
- Immediately responsive ISR/RSTA
- Persistent surveillance
- Target acquisition, designation, attack, and BDA
- Reinforce Brigade Combat Team (BCT) capabilities
- Manned-Unmanned (MUM) teaming
- 2 Sensor Payloads, Communications Relay, Weapons
- System Target Location Accuracy of 25 meters
- Heavy Fuel Engine

System Configuration:

- 12 multi-role Air Vehicles (6 with SATCOM)
- 5 Ground Control Stations
- 2 Portable Ground Control Stations
- 5 TCDL Ground Data Terminals
- 2 TCDL Portable Ground Data Terminals
- 1 Ground SATCOM system
- 4 Automatic Takeoff and Landing Systems
- Payloads: 12 EO/IR, 12 SAR/MTI, 8 WIN-T Communications Payload (WCP)
- Ground Support Equipment

High Altitude - Defined



AIRSHIP OPERATIONAL COST

OPERATIONAL COST PER HOUR BASED ON ONE YEAR IN-THEATER

(Total hours per year = 27 X 1 X 365 = 9,855)

		Cost	Unit	Total	Per Hour
1	POL				
	Diesel: 4 gal per hr	$16.00	9,855	$157,680.00	$16.00
	Oil = 8 qts every oil change each 60 hrs	$32.00	329	$10,528.00	$1.07
	Miscellaneous grease/filters/clamps, etc. per yea	$20,000.00	1	$20,000.00	$2.03
2	Spares				
	3 engines per airship (platoon has 2 airships)	$135,000.00	2	$270,000.00	$27.40
	Other spares	$150,000.00	12	$1,800,000.00	$182.65
	Spare envelopes	$200,000.00	2	$400,000.00	$40.59
3	Support Labor – Mechanics				
	8 major overhauls	$30,000.00	16	$480,000.00	$48.71
	16 minor overhauls per platoon	$10,000.00	16	$160,000.00	$16.24
4	Depot Level Support				
	6 people providing logistics support	$900,000.00	1	$900,000.00	$91.32
5	Ground Support Operations				
	13 people each OCONUS per platoon	$280,000.00	13	$3,640,000.00	$369.36
6	Helium				
	Initial fill = 90,000 ft3 X $0.50 ft3 X 2 X 2	$45,000.00	4	$180,000.00	$18.26
	Leakage per year = 0.75% per day X 365 X 2	$123,187.50	2	$246,375.00	$25.00
	Operating Costs for Airship:				$838.62
7	Sensor pod support				
	Spare sensor pod & support equipment	$3,200,000.00	1	$3,200,000.00	$324.71
	8 people for pod support	$280,000.00	8	$2,240,000.00	$227.30
	Operating Costs for sensor support:				$552.00
	Total Operating Costs for PCOS:				$1,390.62

AIRSHIP COMPARISONS by AMCOM

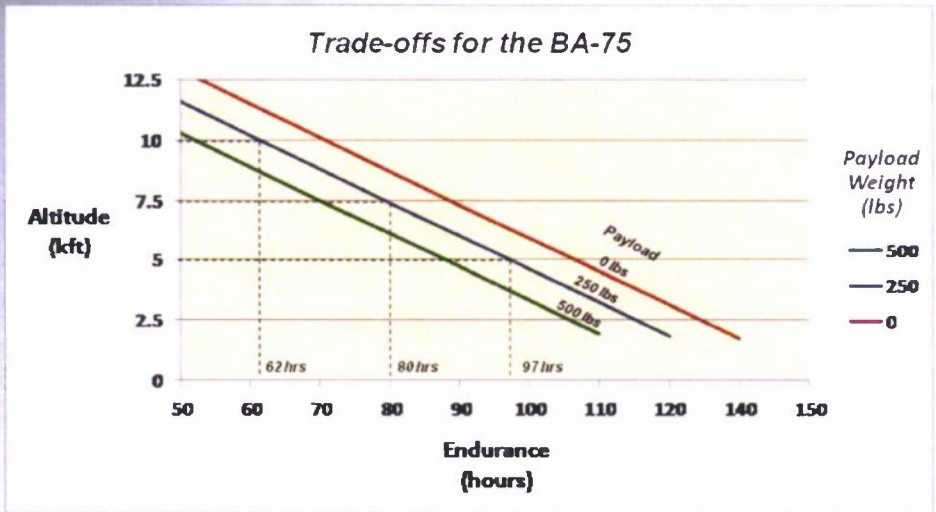
	Airships Capable of Extended Military Missions					
Characteristic	BA-71	BA-145*	A-170	A-200+	Skyship 600	BA-500
Airship Type	Unmanned	Unmanned	Manned	Manned or unmanned	Manned	Unmanned
Envelope Size (l / h / w)	125 / 47 / 34	150 / 53 / 42	178 / /	224 / 68 / 54	197 / 51 / 63	232 / 72 / 60
Envelope Volume (ft^3)	71,300	145,500	170,000	340,000	247,500	497,000
Weight (lbs dry)*	5,040	4,876		9,338		9,658
Payload Capacity (lbs)	450	1,000	2,200	2,500 / 1,000	14 people, plus TV cameras	4,000 lbs max at altitude 5,000'
Endurance (hrs)	18	10	10	>48	50	270 @ 5,000' w/ 1,000lb payload
Speed (cruise / max - mph)	59	55	46		40 / 65	59
Operational Altitude (ft)	10,000	10,000	5,000	15,000 / 20,000	10,000 max	15,000 / 23,000
O&S Cost / year	$7.3M	$7.3M				$9M
Schedule	Available	Deliver in 6 mon			Available	Deliver in 1 yr
Current Status	Operational	Ready for production	Operational	In design stage	Operational for commercial use	In design stage

* *Weight does not include fuel, helium, or payload*

MISSION TRADE-OFF OPTIONS

Operational Trade-offs

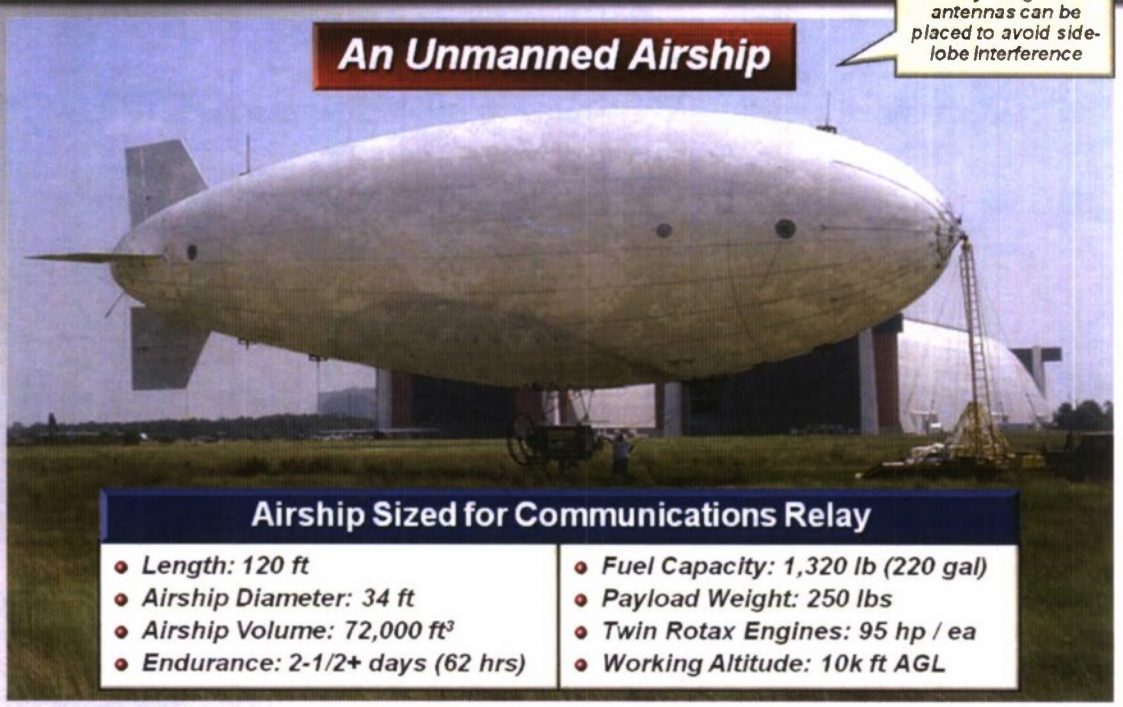
- Fuel Weight (endurance & range)
- Payload Weight (sensors / radios)
- Altitude (AGL)



A Possible Solution

Easily integrated antennas can be placed to avoid side-lobe interference

An Unmanned Airship



Airship Sized for Communications Relay

- Length: 120 ft
- Airship Diameter: 34 ft
- Airship Volume: 72,000 ft³
- Endurance: 2-1/2+ days (62 hrs)
- Fuel Capacity: 1,320 lb (220 gal)
- Payload Weight: 250 lbs
- Twin Rotax Engines: 95 hp / ea
- Working Altitude: 10k ft AGL

THE UNMANNED AIRSHIP PLATOON

Unmanned Airship Platoon

-- 1 Lt, 4 NCO's, & 15 EM --

Platoon Organic Assets

Essential External Support (available in theater)

Envelopes with Power Carts & Payloads—3 (2 Operational + 1 Backup (Crated))

HMMWVs with Shelters & Generators for GCS--3

Remote Video Terminal--3 | Portable Ground Control Station & Data Terminal--1

Inside the GCS

Mooring Masts--3

FMTV--3

Ground Data Terminal--3

Bucket Truck--1

Helium Gas Tankers--3

HMMWV--3 | Storage Trailers--6

OPERATIONAL COST COMPARISONS

Cost and Flight Endurance of Persistent Surveillance Platforms (Sensor cost not included) *

USN Study

Platform	Cost / Flight Hour	Endurance (unrefueled)
AWACS	$20,000	11 hours
JSTARS	$26,500	11 hours
E-2C	$18,700	5 hours
Global Hawk	$26,500	35 hours
Predator	$5,000	40 hours
420K TARS (Stationary Aerostat)	~ $400 **	~ 500 hours
Unmanned Airship	~ $800***	48+ hours

The most cost-effective persistent surveillance platform is an unmanned airship

* "Lighter-than-Air Systems for Future Naval Missions," Naval Research Advisory Committee, 4 Oct 2005.

** Requires constant security force at tethered location on ground – those costs not included.

*** Current projection is approximately $1,200/hour.

AWACS | JSTARS | E-2C | Global Hawk | Predator | TARS | Unmanned Airship

Alternative Systems and Technologies

Best speed range for aerial radio relay

Longest endurance

Item	Unmanned Airship	King Air 350	Hunter UAV
Speed (mph)	0 - 55	264	127
Mission altitude (ft AGL)	10,000	10,000	10,000
Endurance (hours per sortie)	62	6	9
Mission payload Weight (lbs)	250	250	250
Aerial platforms per Platoon *	3	6	4
Crew support rqmt for 6 months	9 pilots/11 crew	12 pilots/12 crew	9 pilots/17 crew

* Only one aerial platform on station at a time.

Least personnel

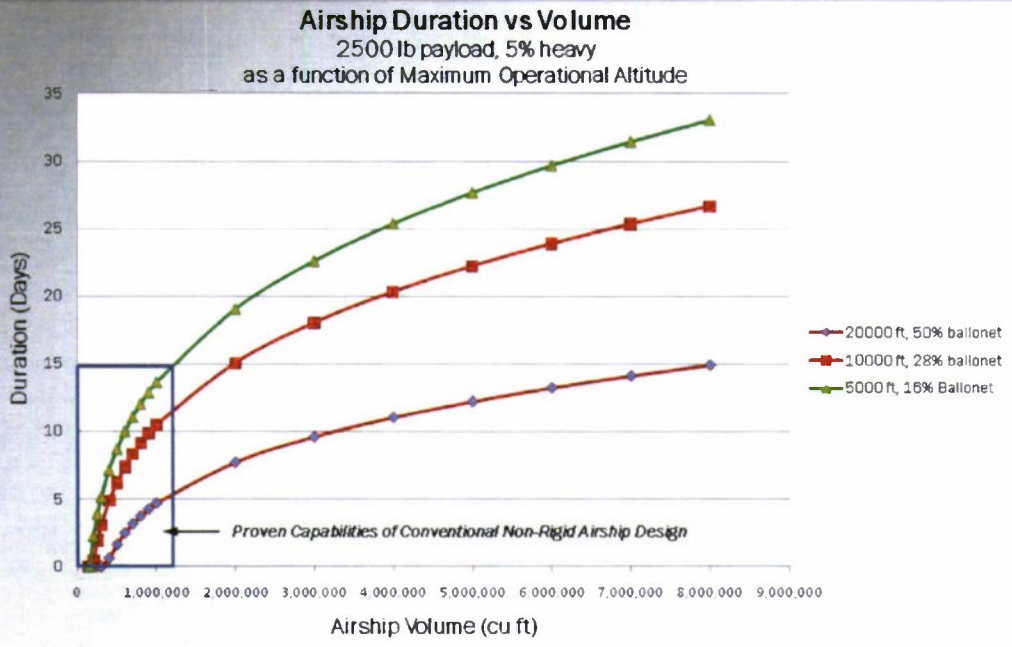
COST SUMMARY COMPARISONS

Cost comparisons include development, procurement, & operations

Development ($M)	4	Unknown *	Unknown **
			
Cost Items	**Unmanned Airships**	**King Air 350**	**Hunter UAV**
Procurement ($M)	22	36	47
Operations ($M)	2.6	8.1	2.5
Total Cost ($M)	24.6	44.1	49.5

* Requires radio & antenna integration and air worthiness testing
** Requires radio & antenna integration and testing

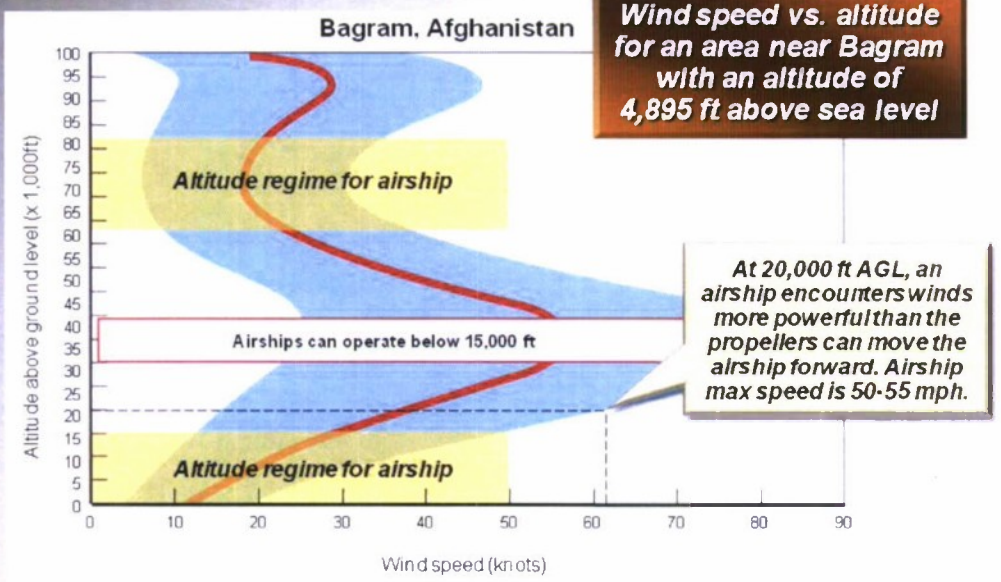
TRADING AIRSHIP VOLUME FOR DAYS ALOFT



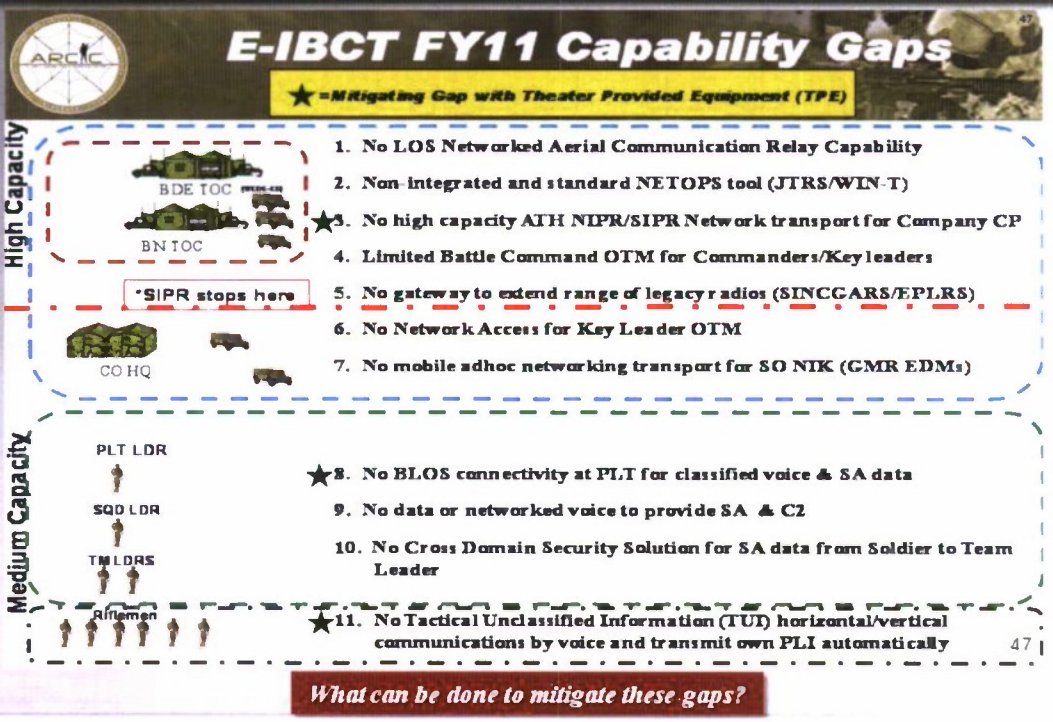
OSD REQUIREMENTS

- *OSD technical objectives for airships:* (Long Endurance RFI)
  - *20,000 ft altitude*
  - *2,500 lb sensor payload*
  - *16 kW payload power*
  - *3 week flight endurance (504 hrs)*
  - *Station keeping*
- *Sizing envelope to meet technical objectives at standard temperature and pressure:*
  - *Fuel estimate:*
    - *30,240 lb fuel wt ((10 gal / hr X 6 lbs / gal) X 504 hrs = 30,240 lbs)*
  - *Dry weight of airship structure:*
    - *5,000 lb total wt of Unmanned Airship platform (best case estimate)*
  - *Payload weight:*
    - *2,500 lb*
  - *Total lift requirement:*
    - *Lift = 30,240 + 5,000 + 2,500 = 37,740 lbs (estimate)*
  - *Envelope volume needed to support this task:*
    - *37,740 lbs / 2.329 lbs / cu meter at STP = 16,204 cu meters or 572,228 cu ft*
    - *At 20,000 ft AGL, you need approximately 50% ballonet or 572,228 cu ft for a total volume of the airship envelope of 1,144,456 cu ft*

WIND SPEED vs ALTITUDE (AGL) – Bagram AFB



Planning for E-IBCT



TPE Equipment per BCT

Specialty

4 x Global Rapid Response Information Packages (GRRIP)
45 x OSVRT

~$35 Million
+ FSR support
+ 50 Mb bandwidth

Transport

21 x CBVSAT
32 x HCLOS
8 x GBS
1 x DVB-RCS Production and User Suite

Automation

24 x servers (X2)
1, 000 laptops (X3)
28 x CPOF
2 x Core switches (X2)
78 x 24-port switches (X2)
4 x Call Managers
32 x TACLANES
1 x TLA stack

Radios

270 x Blue Force Tracker
46 x BFT TOC Kits
148 x S/C TACSAT (PRC-117)
38 x HF (PRC-150)
1,200 MBITR (PRC-148)
1,200 LMR/ICOM/EF Johnson

35 x Iridium
32 x Thuraya
525 x IP phones
64 x cell phones

Phones

Audio/ Visual

3 x Tandberg 6000 VTC
12 x Tandberg 1000 VTC
32 x LCD projectors (X2)
32 x GPS Digital cameras
32 x Plasma screens (X3)

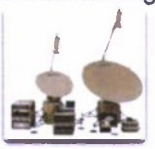
BCT Modernization Overview

- Numerous activities have been initiated to develop the requirements, technical architecture, and acquisition strategy to modernize the BCT
  - Task Force 120 (Purpose: Primary TRADOC Activity)
  - Network Integrated Capabilities Team (Purpose: GOSC Review for TF 120)
  - PM FCS Program Planning (Purpose: FCS acquisition strategy with Boeing)
  - Network Tiger Team (Purpose: Develop ASA(ALT) BCT Modernization Strategy)
  - TRADOC FCS Red Team (Purpose: Independent assessment of FCS)
- Culminates by end of ~Aug-Sept with recommendations to CSA and CG TRADOC

How will the Army integrate all of these ideas?

Company Capabilities

- New -- CPs and ISR
- Companies are required to conduct secret level collaboration while maintaining forward command posts in IW aimpoint
  - Co CP is in addition to BCOTM requirement
  - BLOS capability required in complicated terrain
    - SNAP terminal is in CDRT – Recommended for transition to acquisition program
  - High Capacity LOS (HCLOS) is superior when terrain and distance supports
    - Harris Networking Radio (HNR) – WIN-T INC 2 Solution
    - Harris 7800 radio is in CDRT – Recommended for transition to acquisition program.



Large volume at low echelons makes affordability even more critical

Near-term Enhancement of LWN for Afghanistan

Background

• Maneuver forces (BCTs) and dedicated Combined Security and Training Command teams operating in widely distributed, remote locations have inadequate BLOS communications

- Compartmented terrain in Afghanistan severely limits LOS systems' radio coverage
  - There is no near term <5 years POR which will eliminate this shortfall
- Current needs must be satisfied by Mobile SATCOM Services (MSS): a combination of UHF MILSATCOM, Iridium, and L-band commercial (e.g., Inmarsat)
  - MSS capacity is limited by both availability of upgraded ground terminals and satellite capacity
  - Terrain also affects MSS coverage in some geostationary orbit "shadow" areas

Solutions

• Radically accelerate the fielding of airborne relay!

- Configure "Sky Warrior" for "DEDICATED" comms relay
- Move OIF Sky Warriors to Afghanistan and adapt HNR with antennas
- Move HNR (101st Div assets) to Afghanistan
- How does terrain "help" the relay performance
- Add a common radio – SINCGARS, EPLRS, or UHF SATCOM

Recommend – TASK PEO AVIATION, WITH SUPPORT FROM WIN-T TO FIELD TWO ORBITS BY COB 2010

• Aggressively pursue deployment of upgraded multi-waveform MSS ground terminals: UHF, MUOS, Iridium, Inmarsat, etc.

- When one system does not work, the other often does

Recommend – TASK PEO-C3T TO FIELD UPGRADED MSS RADIOS ASAP

Leverage FCS Progress (2 of 2)

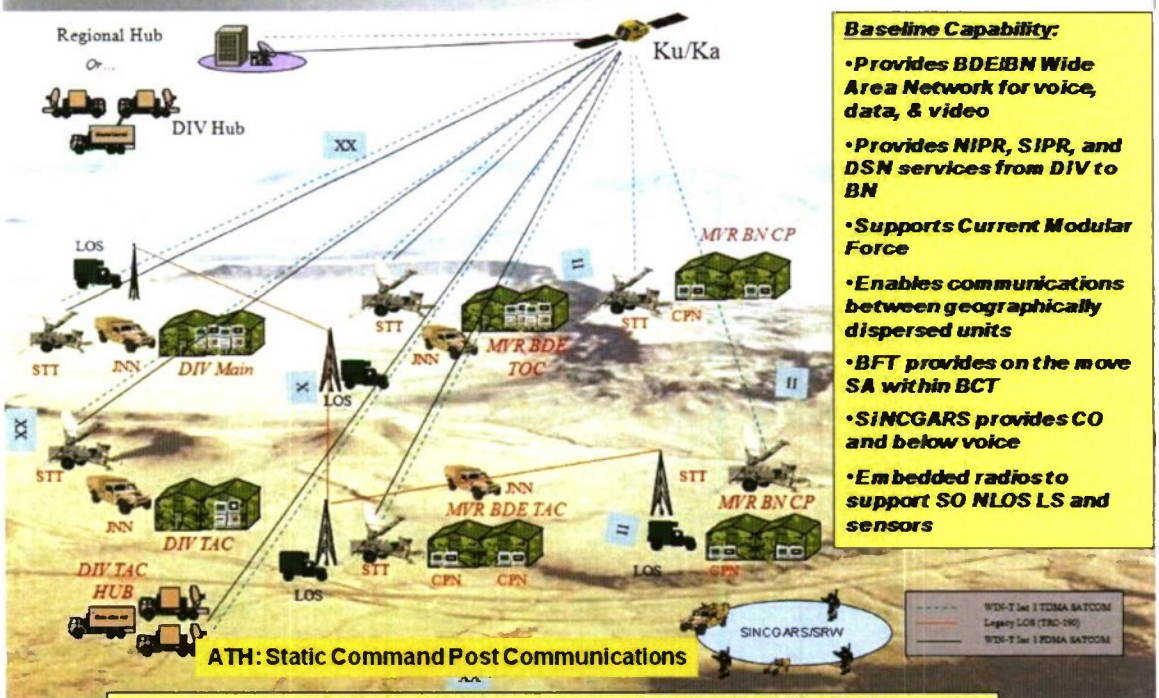
CONCLUSIONS

- Additional analysis and demonstration of LandWarNet additions must be considered for integration into legacy vehicles and into GCVs
  - Gaps/priorities, interoperability with legacy, cost, maturity, SWaP, and cooling
- Alternatives to FCS components and systems to enable Spin Out systems must be assessed
  - Examples: FBCB2 versus ICS/BCS BC; HMS versus GMR

RECOMMENDATIONS

- Task independent assessments for and task demonstration of:
  - Transition of FCS developments into LandWarNet
  - Alternatives applications, hardware and transport to enable Spin Outs

E-IBCT Network FY11
Baseline Capabilities

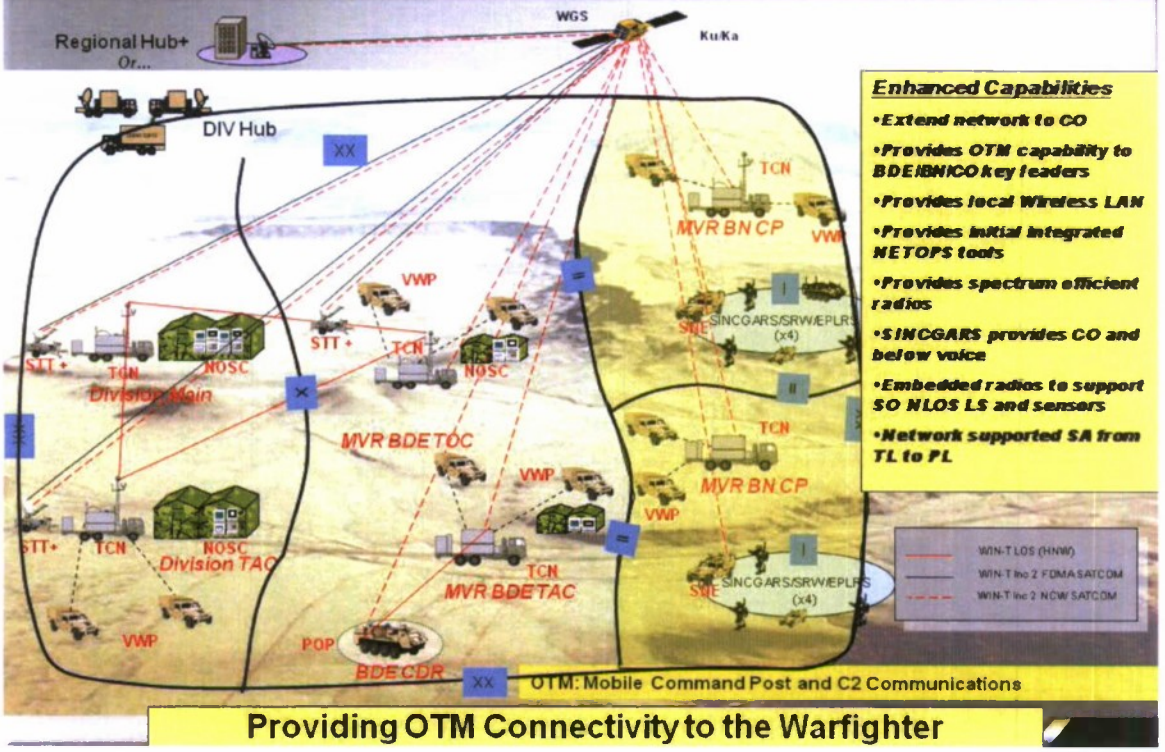


Baseline Capability:

- ***Provides BDE/BN Wide Area Network for voice, data, & video***
- ***Provides NIPR, SIPR, and DSN services from DIV to BN***
- ***Supports Current Modular Force***
- ***Enables communications between geographically dispersed units***
- ***BFT provides on the move SA within BCT***
- ***SINCGARS provides CO and below voice***
- ***Embedded radios to support SO NLOS LS and sensors***

Providing Wideband ATH Connectivity to the Warfighter

E-IBCT Network FY12
Enhanced Capabilities



Providing OTM Connectivity to the Warfighter

JTRS / Serviceable Radios

- Robust Network Capability Enabling: Display/Share Relevant Information; Enable Collaboration; Create & Disseminate Orders

  Company ⟷ Platoon ⟷ Squad
- JTRS is designed to provide terrestrial layer communications
  - Networked radio – supports legacy waveforms
  - Voice and data
- JTRS is available FY13; No final system design for Army formations
- Significant investment in radios through ONS/JUONS
  - Focus on Co and Below BLOS capability w/SATCOM and HF
  - SINCGARS – purchase this year is last
- Capability trades
  - Limited networking w/proprietary waveforms
  - Inability to leverage MUOS available in FY 12

WAY AHEAD: Define JTRS system design for Army formations in 13-14 that affordable, achievable with the greatest operational effects.

Annex F
Abbreviations

Abbreviations

AHP	Analytic Hierarchy Process
AMCOM	Aviation and Missile Command
AMRDEC	Aviation and Missile Research, Development and Engineering Center
AoA	analysis of alternatives
ARSTRAT	Army Forces Strategic Command (SMDC)
ASA(ALT)	Assistant Secretary of the Army for Acquisition, Logistics and Technology
ASB	Army Science Board
BCT	brigade combat team
C^4ISR	command, control, communications, computers, intelligence, surveillance and reconnaissance
CDL	common data link
EO/IR	electro-optic/infrared
EPLRS	Enhanced Position Location Reporting System
G–3	Deputy Chief of Staff for Operations
GEO	geosynchronous Earth orbit (satellites)
GiG	Global Information Grid
HAFW	high-altitude fixed wing
HALTA	high-altitude lighter than air
HDRS	high data rate satellite
HMS	handheld, manpack, small form fit (JTRS type)
HNW	highband networking waveform
HQDA	Headquarters, Department of the Army
IPT	integrated product team
JEFX	Joint Expeditionary Force Experiment
JFEX	Joint Forces Exercise
JTRS	Joint Tactical Radio System
LDRS	Low Data Rate Satellites
LEO	low Earth orbit (satellites)
LTA	lighter than air
MAFW	medium-altitude fixed wing
MALTAHL	medium-altitude lighter-than-air heavy lift
MALTAML	medium-altitude lighter-than-air medium lift
MARW	medium-altitude rotary wing
MR TCDL	Multirole Tactical Command Data Link
MUOS	Mobile User Objective System

OSD	Office of the Secretary of Defense
PCSR	Persistent Communications, Surveillance and Reconnaissance
PEO	program executive office
PEO/C^{3}T	Program Executive Office for Command, Control and Communications – Tactical
PEO/IEWS	Program Executive Office for Intelligence, Electronic Warfare and Sensors
POR	program of record
SATCOM	satellite communications
SIGINT	signals intelligence
SINCGARS	Single Channel Ground and Airborne Radio System
SMDC	Space and Missile Defense Command
SR	surveillance and reconnaissance
SRW	soldier radio waveform
SWAP	size, weight and power
TACSAT	tactical satellite communications
TCDL	Tactical Common Data Link
TOR	terms of reference
TRADOC	Training and Doctrine Command
UAV	unmanned aerial vehicle
UHF	ultra high frequency
USA	United States Army; Under Secretary of the Army
USD	Under Secretary of Defense
USMA	United States Military Academy
WGS	Wideband Global SATCOM
WIN-T	Warfighter Information Network – Tactical
WNW	wideband network waveform